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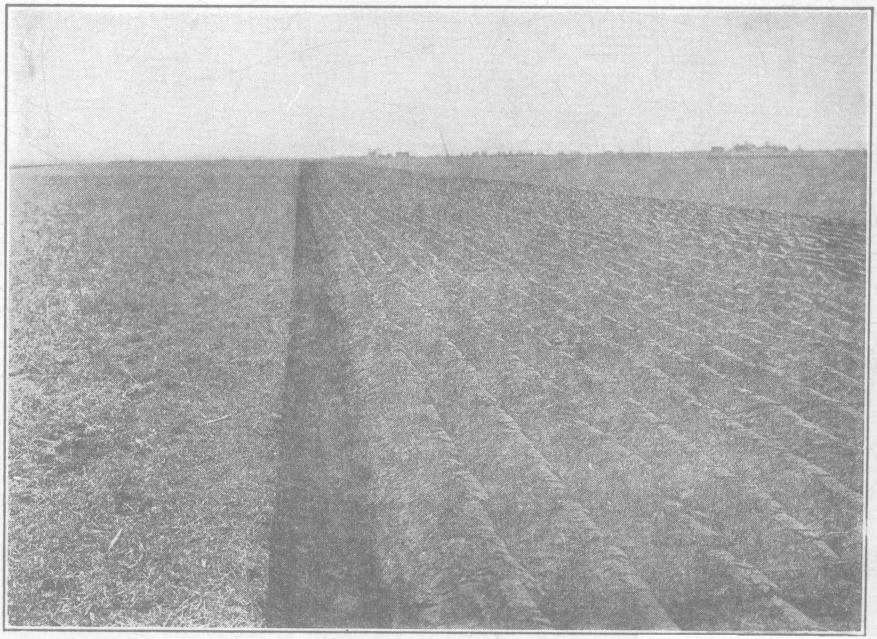
Plows and Good Plowing



The Work of a Master

Prepared by
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THE OHIO STATE UNIVERSITY AND THE UNITED STATES DEPARTMENT OF AGRICULTURE, COOPERATING
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FREE—Cooperative Agricultural Extension Work—Acts of May 8 and June 30, 1914

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Read pages 3 to 9. Then find your particular type of plow in the following list. Read carefully the material devoted to your plow.

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Bulletin 80, Eighth Edition
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Plows and Good Plowing

By
C. O. REED and E. A. SILVER

QUALITY PLOWING has an important bearing on both soils and crops. More power is consumed in plowing than in any other field operation; and for efficiency, the quality of plowing should be as high as possible for the energy expended.

This bulletin is issued to contribute toward greater efficiency in Ohio's plowing operations. It is written primarily for plowmen; and, although it is not a complete treatise on plows and plowing it

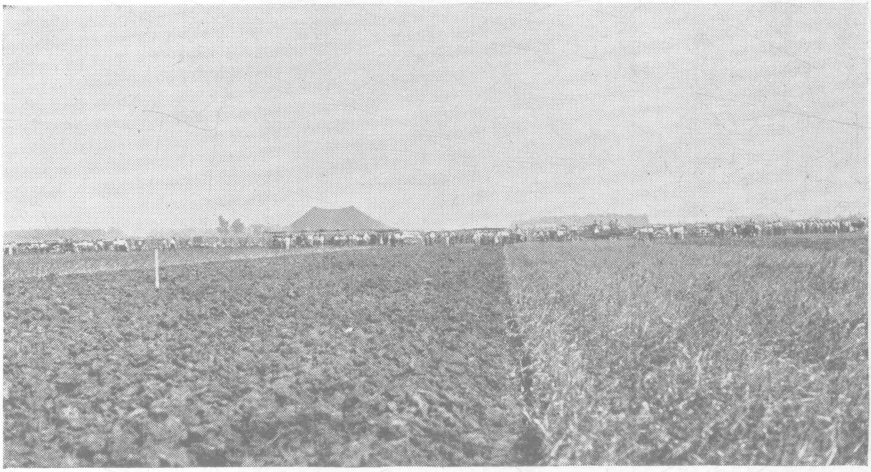


Fig. 1 a.—Ohio has good plowmen. A prize plot at a Mercer County plowing match.

contains very pertinent and highly practical suggestions regarding adjustments and troubles of most of the common types of plows now on Ohio farms.

Read the important preliminary considerations in paragraphs 1 through 16. The subject matter thereafter is arranged according to type of plow. In the Contents on page 2, find the type of plow

NOTE: Some of the material in this bulletin, and the arrangement, is the result of a meeting of plow experts and a number of other individuals interested in good plowing.

you have. Then read carefully the pages devoted to your plow. Paragraphs are numbered to facilitate reference. Although the illustrations show right hand horse plows, the subject matter is applicable to left hand as well as to right hand plows.

PLOWING MATCHES POPULAR

Because of their value in promoting the art of plowing, plowing matches have become quite popular in Ohio. They are fostered by the Agricultural Extension Service through its county agents cooperating with local committees. The accompanying score card shows one evaluation of the various characteristics of good plowing described briefly in paragraphs 1 through 8.

SAMPLE SCORE CARD OFTEN USED AT PLOWING MATCHES

Characteristics	Maximum points allowed	Score per Inspection					Aggregate points	Average
		1	2	3	4	5		
Conformation of Furrow Crowns smooth and of even height	15							
Granulation	10							
Uniformity of Depth	10							
Uniformity of Width	10							
Trash Covering	15							
Straightness	15							
Backs and Deads Backs low and even Deads shallow and clean	15							
Appearance at Ends Ends even Depth maintained	10							
						Total Points.....		
Points deducted for penalties..... (Failure to finish within alloted time; failure to meet depth requirement; excess help used; violation of rules; etc.)								
						Final Score.....		

1. Good Granulation.—Maximum granulation of the furrow slice is usually sought when plowing is to be followed relatively soon by seeding. In fall plowing preparatory to spring seeding, coarser granulation is advisable from the standpoint of good soil practice, especially if the soil be "heavy" or disposed to puddle.

In plowing for corn borer control, however, one should always strive for as high a degree of granulation as is consistent with soil tilth. If the soil comes up in clods between which the trash is exposed to view, some subsequent tillage operation should be per-

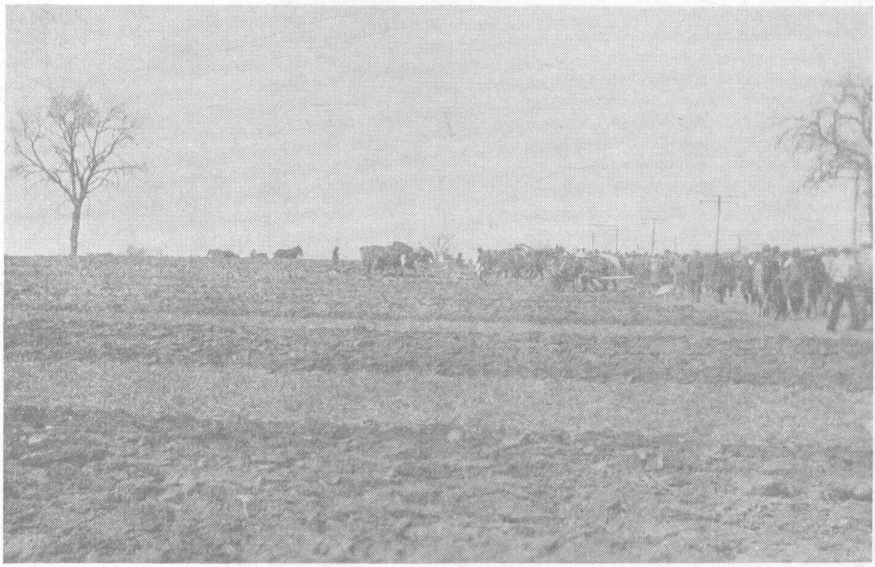


Fig. 1 b.—The skill of plowmen is judged by large crowds. A Logan County plowing match.

formed in order to pulverize the surface further, to fill the fissures between the clods, and to hide or bury all trash.

2. Complete Covering and Mixing of Trash.—Trash should be completely buried; no trash should appear even in the creases between the furrow slices. Unless the main object of plowing is to reduce a very tough or virgin sod, the trash should, if possible, be well mixed with soil rather than laid down as a heavy mat on the plow sole. From the standpoint of corn borer control, the trash should be covered not only completely, but also so deeply that none will reappear on the surface.

3. **Uniform Consistency throughout the Depth of the Turned Furrow Slices.**—A layer of finely granulated soil on top of a layer of clods does not necessarily mean that the field is well plowed, although the surface alone might so indicate. A reverse condition is not objectionable, provided the clods in the surface do not interfere with trash covering.

4. **Good Formation of Surface.**—The crowns of the turned furrow slices should be smooth, of equal height and of equal curvature. The degree to which the slices are turned varies with custom and with types of plow bottoms, but there should be uniformity throughout the length of any slice and across all slices in the same "land."

5. **Uniform Depth and Width of Furrow.**

6. **Straight Furrows.**

7. **Low, Even, Clean Back-furrows, and Shallow, Clean Dead-furrows.**—In some localities, rather deep dead-furrows are considered necessary for drainage purposes. But no dead-furrow should show spots of newly turned subsoil unless the operator is purposely increasing the depth of the plow sole.

8. **Even, Clean Furrow Ends.**

CONTROLLING FACTORS

9. Excluding such considerations as the ability of the plowman and the kind of soil, good plowing depends upon the major factors of:

(a) Plowing when the condition of the soil is right;

(b) The type and shape of plow bottom;

(c) The relation between the depth of plowing and width of plow;

(d) The correct width of furrow slice for the plow at hand;

(e) Keeping the plow bottom in normal position with relation to the furrow slice;

(f) Speed;

(g) Previous surface treatment; and

(h) The proper care, set, and adjustments of the plow.

RELATION OF DEPTH AND WIDTH

10. Usually a common plow bottom is designed to do its best work at a depth equal to one-half its normal width when operated at normal speed under good plowing conditions. This does not mean that an 18-inch plow will not work well when plowing 5 inches deep, or that a 12-inch plow will not do good work when plowing 8 inches deep. It simply means that, departing from the ideal depth-width relation, poorer work and poorer trash covering may result. However, if you use a wide bottom plow in soil which has

Courtesy of U. S. Department of Agriculture.

Fig. 1 c.—A good job of trash covering by a farmer-owned outfit.

not previously been plowed deep, be very cautious about how rapidly you drop into the old plow sole. Unless you are sure that no ill effects to the productivity of the soil will result, it may be best to take three or four seasons to increase the depth of plowing 2 or 3 inches.

INFLUENCE OF WIDTH

11. Usually a common plow bottom is designed to do its best work when plowing its normal width, if operated at normal speed under good plowing conditions. If you do not know the size of your plow, your dealer should be able to tell by the number of the plow and the number of the moldboard and share.

12. Recently, much has been heard about wide bottom plows for corn borer work. Experience on many farms has proved that, even under severe conditions, excellent jobs of trash covering can be accomplished with 16-inch and 18-inch bases. The consensus of opinion seems to be that, generally speaking, it is easier to cover trash with the wider bases. With some limitations, however, excellent jobs of trash covering can be accomplished with the smaller bases if the plowman will use care and patience. At least there is a chance for considerable improvement in plowing with the bases which are now common and which the farmers may not yet be ready to displace.

In plowing under corn stubble, a 12-inch or a 14-inch plow, properly equipped, will usually handle stubble up to a height equal to the width of the plow bottom. If the stubble be higher, see paragraph 15. In plowing under a light growth of whole stalks, a one-bottom 12-inch plow, or a 14-inch gang plow, properly equipped, usually will do good work. As the stalk growth gets heavier these smaller widths of bottoms, especially of the gang type, are likely to become more troublesome, until, in very heavy growths, the 12-inch gang plow often fails, because of lack of sufficient clearance between the bottoms.

Fourteen-inch gangs, properly equipped, are often used successfully in fairly heavy growths, especially if the stalks are well broken over and lie in the direction of the plowing. If the plowman feels that his plow will not handle whole stalks satisfactorily, he still has the opportunity of raking and burning the corn stalks before plowing.

INFLUENCE OF KEEPING PLOW BOTTOM IN NORMAL POSITION

13. Each plow base is designed for a definite relative position in respect to the furrow slice. Poor condition, poor sets, misadjustments, or hitches which actually force the plow bottom from its correct position, threaten to lower the quality of work and cause poorer trash covering. Throwing a plow "on its nose," winging it up or down, excessive sidedraft—all of these tend to rob the moldboard of its ability to handle the furrow slice as it is designed to do. Poor sets and misadjustments not only affect granulation, furrow slices, crowns, and scouring, but also may cause trash to pitch so that it cannot be covered properly.

INFLUENCE OF SPEED

14. A plow bottom is designed to do its best work, under good plowing conditions, at a speed normal to the kind, shape, and size of bottom. The normal plowing speed of horse plows is about 2 miles per hour and that of many tractor plows about 2¼ to 2½ miles per hour. Special speed bottoms have been designed for tractors, operating at 4 miles per hour. The proper speed may vary somewhat with the seasons and soil conditions, and slight changes in speed may have marked effects. If a plow is run too slow or too fast, it may not handle the furrow slice well, granulation may be adversely affected, trash covering may be poor, nonscouring may result, there may be an objectionable difference in consistency between the upper and lower layers of the turned furrow slices. Speed is important from several standpoints. Give it attention.

PREVIOUS TREATMENT OF SURAFCE TRASH

15. If corn stubble or whole stalks are to be broken over to enable the plow to handle them better, it is advisable to do this breaking over at a time when the stalks will not be broken free from the roots. The trash usually plows under much more easily if the roots hold it. The stubble and stalks should be broken over in the direction of plowing.

16. In some sections farmers are successful in disking stalks before plowing. In other localities, where the soil condition and stalk growth are different, a previous disking or stalk-cutting operation seems to prove a handicap to the plow, insofar as handling trash is concerned.

WALKING PLOWS

The walking plow should be in such condition and be so set or adjusted that it will run without much guiding by the operator unless he is plowing in stony or stumpy ground, where heavy trash abounds, or where the soil conditions vary materially. Unless the plow has a bent beam, bent frog or badly worn landside, such an ideal set is possible in all common serviceable walking plows if the operator will secure and maintain the proper down-suck, land-suck, wing bearing, sharpness, hitch, and set and condition of beam wheel, jointer, coulter, and special covering devices.

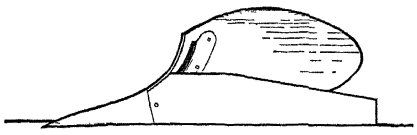


Fig. 2.—Plow shares have down-suck.

17. Down-suck and Land-Suck.—The points of all walking plow shares dip down slightly below the plane of the underside of the landside as shown in Fig. 2. This is known as down-suck. The land-suck, as shown in Fig. 3, is the distance which the point of the share extends into the unplowed ground beyond the plane of the land face of the landside. These "suck" features have very decided influence in holding the plow steadily to its depth and width. They also influence draft, quality of work, and effort on the part of the plowman.

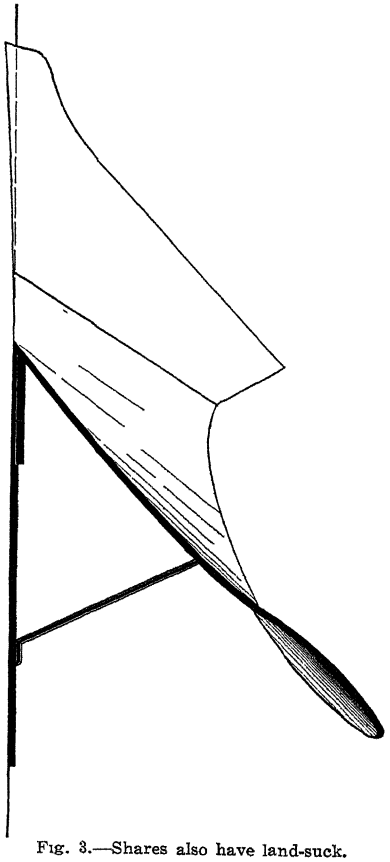


Fig. 3.—Shares also have land-suck.

18. Inasmuch as cast shares cannot be forged, the operator has no control over the down-suck and land-suck of cast shares other than to supply new ones as wear robs the plow of these necessary features. Be sure, however, to supply the right kind, shape and size of share for your particular plow. The operator need pay no attention to the down-suck and land-suck of new steel shares if he purchases the right kind and size. However, in sharpening and in repointing steel shares by forging, great care

must be taken to maintain the proper down-suck and land-suck in so far as these features are built into the share itself. Lay the finished steel share on a smooth surface, as shown in Fig. 4, and check on the down-suck at points A and B. Ordinarily, the clearance at each of these points should be very close to ⅛ inch. Sometimes for plowing ground that is very hard, in wide cut shares, or in tractor plows, these clearances are increased slightly; but great care must be taken to bend the share well back from the point, as in A and B in Fig. 4, instead of simply bending the tip of the point downward. Be careful, too, not to put in too much down-suck. If these two precautions are not heeded the plow will "bob," that is, it will jump, gouge, run unsteadily, and even fail to hold its depth. After a steel share has been forged sharp or repointed, check also on what land-suck the share itself carries. Hold a straight edge along its land face as shown in Fig. 5. Ordinarily, the share should show from 1/16- to ⅛-inch clearance at C.

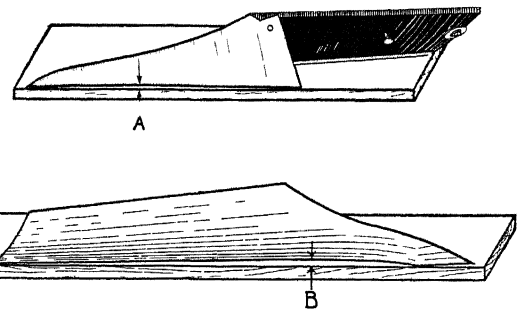


Fig. 4.—Measure the down-suck of a new steel share. Know how much your shares should carry.

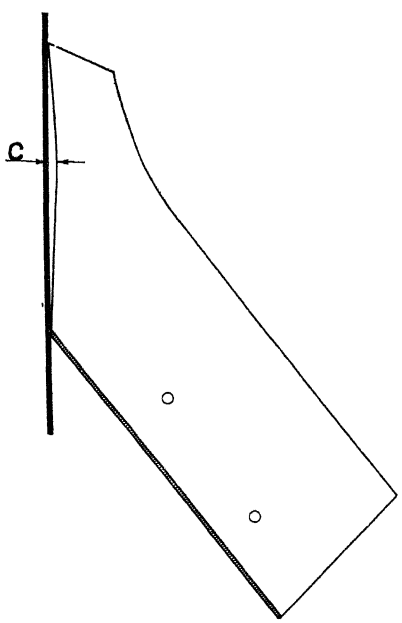


Fig. 5.—Measure the land-suck which a new steel share carries. It will help when you have shares repointed.

19. The measurements for down-suck and land-suck vary slightly between plows of different makes and widths. If there is any question as to what measurements the share of your particular plow should carry, measure a new share made especially for your plow. Preserve these figures, and give them to the blacksmith when you have the shares forged. Proper running of the plow depends also on the perfect fit of the share, on drawing the share

down tight, on replacing a badly worn landside, and on supplying a new share when the old one has become worn back so badly that it is stubby. Excessive wear in both share and landside tends to upset the proper down-suck and land-suck features.

20. Wing Bearing.—The bottom or base of the walking plow has two bearing surfaces to work against the bottom of the furrow. Part of the down-thrust of the plow is carried by the heel of the landside shown in Fig. 6; part is carried by the flattened portion of the outside corner of the share at W. Hold a straightedge across the bottom of plow (Fig. 6), so that it rests on heel of landside and on wing of share. The length of contact between the wing and the straightedge at W is the **wing bearing.** This feature in walking plows is extremely important and often misunderstood. If the plow has too much wing bearing the plow will not suck in properly on the wing side, and we say the plow "wings up." It then tends to run narrow or "out." If the plow has too little wing bearing, it "wings out" or tends to run "wide." We want more wing bearing in walking plows when the soil is mellow than when the ground is hard and compact. Obviously, a walker with the proper amount of wing bearing to run level in fall plowing may "wing down" in spring work, or a walker which worked perfectly in the spring may act badly when the same share is used in the fall. If a walker tends to wing up or wing down, and if the operator attempts to overcome the difficulty by setting the hitch over; or if he overcomes the tendency to run wide or narrow by fighting the plow through the handles, then the plow bottom may not be kept level in its proper relation to the furrow slice. This condition has a marked effect on trash covering and quality of work. A plow that wings up and is then pulled back to its width by the hitch is almost sure to pitch trash in such a way that the trash will lie close to the surface or will appear on the surface. Hence, in addition to its influence on quality of work, wing bearing in walking plows is of extreme importance from the standpoint of corn borer control.

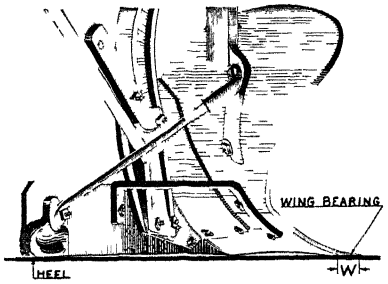


Fig. 6.—The amount of wing bearing in walking plows is very important.

21. For average plowing conditions, regular steel shares on walking plows should carry wing bearing approximately as follows: 12-inch walkers, ¾ inch; 14-inch walkers, 1¼ inches; 16-inch walkers, 1½ inches. Wing bearing on cast shares cannot be changed,

except that it can be lessened by carefully chipping off a little of the wing. Wing bearing on steel shares can be increased or decreased by forging, or by carefully bending the wing slightly up or down with a well closed monkey wrench when the share is cold.

22. **Sharpness.**—A blunt point, a dull cutting edge, or a badly worn wing will not only upset the proper running of the plow but will also increase draft. Usually, all three of these bad conditions exist in the same share at the same time. A blunt point and dull cutting edge in a cast share may be slightly and very temporarily remedied by chipping, or the point and cutting edge can be ground. However, trying to get along with a worn-out cast share, is a hard task. Considering draft, quality of work, and one's time, it is doubtful if such a practice pays. Crucible steel shares may be filed, ground, or forged sharp; but soft-center steel shares should not be filed or ground; they should be forged only. If the point and wing of a steel share are badly worn back, but the body of the share is still serviceable, new steel should be added by the regular "repointing" and "rewinging" processes, care being taken to maintain the proper down-suck, land-suck, and wing bearing as described in paragraphs 17, 18, 19, 20, and 21.

23. Do not throw away steel shares, especially soft-center steel shares which can profitably be repointed, rewinged, and sharpened. Space here does not permit description of these processes. If you are not equipped to perform the work, take your shares to a good blacksmith and give him the dimensions you have for down-suck, land-suck and wing bearing. If you are near the factory that built the plow, perhaps it will be best to return steel shares to the factory for redressing. In any event, remember the importance of sharpness and of maintaining the proper sets in the share.

24. **Hitch.**—When a plow bottom is working, its center of load or center of resistance, for all practical purposes, may be considered an imaginary point 2 inches from the shin of the plow and just below the surface of the ground as indicated by C in Fig. 7. Suppose you could fasten one end of a string to the center of resistance; then you passed the string through the pin that fastens the horizontal clevis at the bridle of the plow; then you pulled the string tight as you held its other end at a point about 3 inches above the hame hook on the furrow horse's collar. The string would illustrate the "line of hitch"; this is indicated by the heavy lines in Figs. 7, 8, and 9. In other words, the line of hitch is an imaginary line, straight or broken, extending from the center of resistance to a point approximately 3 inches above the hame hook of the furrow horse, and passing through the point of contact between the team

and the plow. The line of hitch is one of the chief factors controlling the front end of the beam. A good understanding of its influence and control is essential.

25. If a walking plow is to run properly under good plowing conditions, the line of hitch should be straight as shown in Fig. 7. This shows the vertical view, or pictures the line of hitch in the vertical plane. Keeping the plow bottom in good working condition as described previously, and getting the hitch at the right height

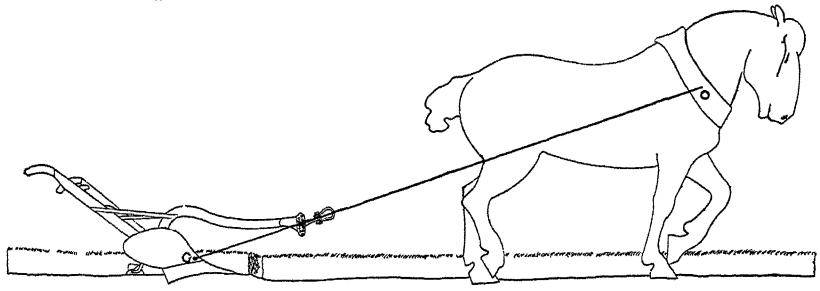


Fig. 7.—For ease, good work, and steady running, keep the line of hitch as straight as possible.

on the plow bridle are the chief factors under the operator's control by which he can keep the line of hitch straight.

26. If you set the clevis too high, it is set to break the line of hitch upward, as shown in Fig. 8, and when the team pulls, a force will be exerted downward at the front end of the beam because the line of hitch always tends to straighten. This tendency of the line of hitch to straighten operates to force the plow deeper, and that force will continue until the plow has dropped enough to let the

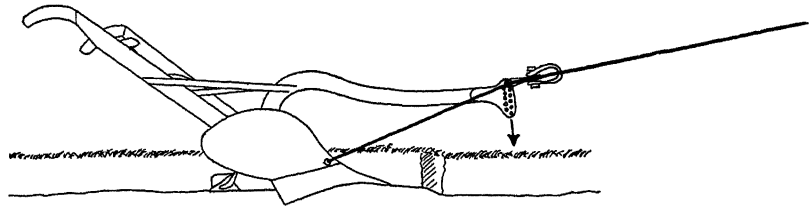


Fig. 8.—A broken line of hitch always tends to straighten. Hitching too high tends to force the beam downward.

line of hitch become a straight line. If the operator bears down on both handles to keep the plow from running deeper, he teeters the plow over the heel and wing as pivots; he rides the handles to offset the force downward at the front end of the beam due to the broken line of hitch. The plow will not be held steady, it will tend to weave, and the operator is forced to work harder than necessary. (See Beam Wheel, par. 33.)

27. If the clevis is set too low on the bridle of the plow, it is set to break the line of hitch downward, as shown in Fig. 9. When the team pulls, a force will be exerted upward on the beam. This condition operates to destroy the sucking-in action, and the plow will tend to come up to a lesser depth until the line of hitch automatically becomes straight. If the operator lifts on both handles to keep the plow to its depth, he will carry some of the weight which should be riding on the heel and wing, just as one carries some of the load when he lifts up on the handles of a wheelbrarrow. When a wheelbarrow is raised it is not so steady as when setting on its two legs. Likewise, a plow is not steady in the furrow when the plowman is carrying the handles in order to fight the line of hitch.

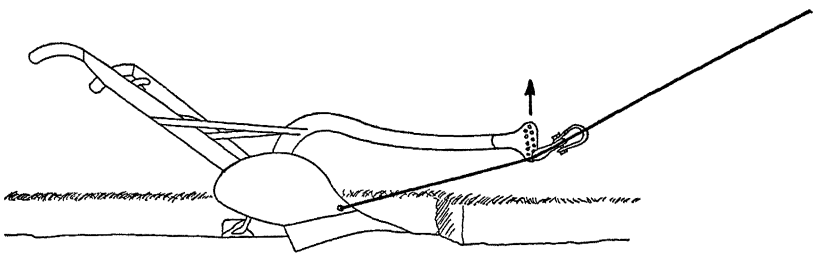


Fig. 9.—Here, a force upward is introduced at the front end of the beam

28. As the share becomes dull the plow begins to ride out, and the operator raises the hitch in order to introduce a force downward sufficient to make up for the loss of suck. Then the plow tends to teeter over the point of the share, the weight on the heel and wing is lessened, the plow is apt to weave because it is not held steady by natural forces, and it requires more guiding through the handles.

29. The plowman should remember, too, that in order to keep the line of hitch straight, a small team should be hitched to the bridle of the plow at a lower point than a large team. Likewise, a close hitch requires a higher point of contact on the plow bridle than when the traces are lengthened considerably. If free to do so, the tugs or traces of the harness will assume a straight line from the hame hooks to the plow bridle—they indicate the forward part of the line of hitch. If the belly-bands, backstraps or hip straps on the team are too short, the traces may be prevented from assuming a straight line and sore backs, sore hips, or chafed bellies may result. If a big team is hitched too close to a walking plow there may be too much down pull on top of the horses' necks and sores may result.

30. Now let us consider the line of hitch in the horizontal plane, that is, looking down on it, as illustrated in Figs. 10 and 11.

The point of application of the force of a two-horse team, for all practical purposes, may be considered at F, half way between the horses' collars. In a three-horse team it would fall, for all practical purposes, at the center of the middle horse's collar. If the plow is to run steady and without guiding under good plowing conditions with the plow in good shape, the line of hitch in the horizontal plane should be straight, as indicated by the solid line in Figs. 10 and 11.

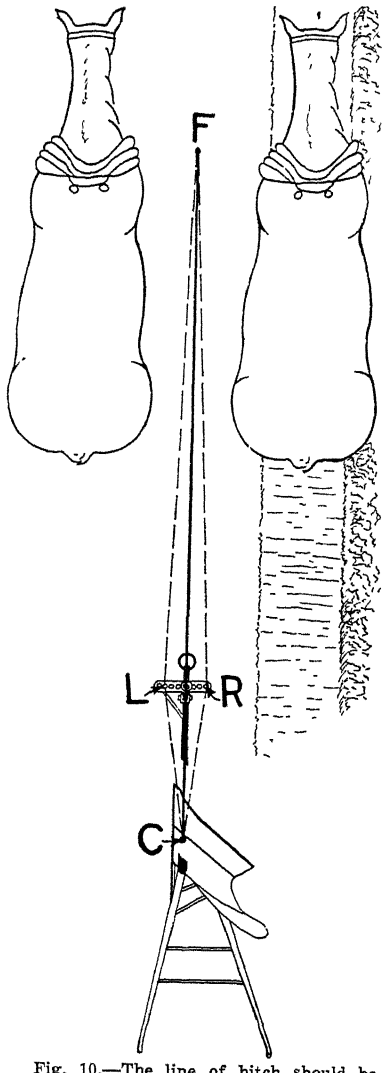


Fig. 10.—The line of hitch should be straight horizontally as well as vertically. Hitching too far to left or right will break it.

31. If the hitch on the bridle of the plow is too far toward the unplowed ground, the broken line CLF will tend to straighten, and the plow will run narrow unless the operator actually holds it to its width by bearing down on the furrow handle and raising on the land handle. An opposite condition is set up if the hitch is too far toward the plowed ground. If a plow bottom has too little land-suck, or too much wing bearing, it will tend to run narrow. If there is too much land-suck or too little wing bearing, it will tend to run wide. Either of these tendencies may be overcome by the hitch. But, if the hitch is used to make up for a poor condition of land-suck, down-suck, or wing bearing, the plow will not run properly, it will not be steady, quality of work and draft may be materially affected and the operator will have to work harder than when all sets are properly made. The principles of hitch are practically the same for both steel beam and wooden beam plows. When you shift the front end of the wooden beam to the right or left, you simply shift the beam into the line of hitch; then you can move the clevis to the right or left on the horizontal clevis of the plow.

32. Frequently a doubletree or two-horse evener that is too long is used. When two horses are used on a walking plow, and when the plow is cutting its normal width of furrow, the length of the doubletree between the outside holes should be as nearly as possible 32 inches for a 12-inch walker, 38 inches for a 14-inch walker, and 44 inches for a 16-inch walker. Then the two horses should be reined so that each walks straight ahead. Three horses should be so reined as to avoid crowding.

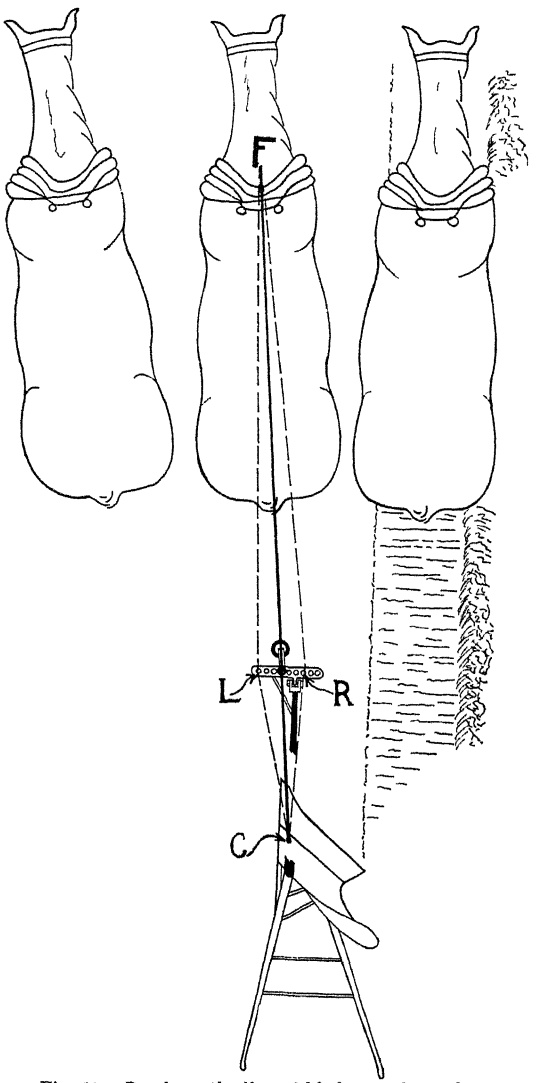


Fig. 11.—Breaking the line of hitch may force the operator to fight the plow, and the implement will not run steady.

33. **Beam Wheel.**—The beam wheel, or gauge wheel is necessary where an even depth of plowing is sought throughout a field containing a variety of soil conditions or hard and soft spots. The beam wheel is advantageous, also, when a rolling coulter is used.

Under such conditions set the hitch high enough to secure the desired depth in that part of the furrow where the ground is the hardest; lower the beam wheel until it touches the surface of the ground lightly, then raise the hitch one hole. The line of hitch will then hold the plow to its depth through the hard spots, and the beam wheel will keep it from running too deep through the softer spots. When not needed. the beam wheel is apt

to become a useless source of repair expense and even a disadvantage from the standpoint of the team. Too many operators use the beam wheel instead of the line of hitch to control depth. If one uses the beam wheel to gauge the depth of plowing, and then is careless about the height of the hitch, he may be forcing the beam wheel to carry the down thrust of a broken line of hitch, and heavier draft will result.

If the beam wheel is used under good plowing conditions, secure the depth of plowing by the hitch; lower the gauge wheel until it touches the surface of the ground; then raise the hitch one hole.

34. **Jointer.**—The jointer cuts out a narrow, shallow "ribbon" of soil just above and a little ahead of the plow. In so doing, it performs four important functions. (1) Any trash which it can handle is moved over on the furrow slice toward the plowed ground in position to be buried deeper. (2) A little soil is thrown on top of the trash to lessen its tendency to "pitch." (3) The removal of the ribbon of soil materially aids in preventing trash from appearing in the creases between the turned furrow slices. (4) The use of the jointer often reduces the air spaces under the slices.

35. Care must be taken to set the jointer properly, and to keep its point full and sharp. When the jointer is used without a rolling coulter, standard rules for jointer set are: (1) Move the jointer forward or backward on the beam until the point of the jointer is approximately over the point of the share. (2) Raise or lower until the point of the jointer cuts from 1½ to 2 inches deep. (3) Adjust the jointer shank at the beam, or turn the jointer proper on its shank, until the point cuts from ⅜ to ⅝ inch "to land," that is, from ⅜ to ⅝ inch farther into the unplowed ground than the shin of the plow. The above rules are for small jointers. They also hold for large jointers, except that these usually are set a little deeper. Slight variation from these standard rules is sometimes necessary. On rough ground a slightly deeper set may be advantageous. Setting the jointer deeper usually causes it to throw more soil on top of the trash, and to throw its own slices a trifle farther. Pitching the jointer down, that is, causing it to set at a greater angle to the ground surface, or setting it to cut slightly more "to land," will often overcome non-scouring in the jointer itself. If set too flat, the jointer will not cut cleanly. All of these adjustments have rather marked effect, and, starting with the standard set given above, the operator may do well to experiment intelligently and systematically until he finds the best combination of sets for the surface and soil conditions at hand..

36. The jointer can be used alone in short trash which is either loose or fast; but, unfortunately, it clogs badly when used alone in long trash. It is helpful in plowing under corn stubble where there is not much long trash between the rows. In plowing under whole stalks the jointer, if used, should be accompanied by a rolling coulter, unless some other equally effective device is used in combination with the jointer. (See Combination Jointer and Coulter, pars. 45 and 46.)

37. **Coulter (Stationary, Standing, Knife Coulters and Cutters).**—Keep sharp, and keep the plane of the blade parallel to the plane of the landside. If a stationary or knife cutter or coulter becomes bent to lead into or out of the land, shim it to lead straight. With the exception of "fin" cutters, stationary coulters and cutters are not well adapted to heavy trash conditions. (For Rolling Coulters, see pars. 38 to 44.)

38. **Coulter (Rolling and Caster).**—Rolling coulters are so effective in long or heavy trash, and so valuable in getting corn crop debris under, that manufacturers are now supplying light rolling coulters for walking plows as well as larger coulter blades for riding and tractor plows.

39. The rolling coulter performs three important functions: (1) It helps cut the furrow slice free vertically, thus assisting in securing a clean cut furrow wall, and usually lessening draft. (2) It cuts through trash which otherwise might drag on the shin and beam. (3) By cutting the trash into shorter lengths, it enables the plow bottom to cover better.

40. The set of the coulter is extremely important. For ordinary plowing conditions move the coulter forward or backward until its bearing is approximately over the point of the share, as shown in Fig. 12. In stubble plowing, lower the blade until it cuts from one-half to two-thirds the depth of the furrow, and $\frac{5}{8}$ inch "to land," that is, $\frac{5}{8}$ inch farther into the unplowed ground than the shin of the plow. In sod plowing, lower the blade to cut from two-thirds to the entire depth of the furrow, and $\frac{1}{2}$ inch to land. These are standard rules for coulter set. They cannot be adhered to strictly for all conditions, as is indicated in the next few paragraphs. Under adverse or unusual conditions the plowman may do well to experiment until he finds the best combination of sets for his conditions, but he should keep as close to the standard rules as possible. How close he can adhere to the standard rules depends somewhat upon how perfectly the plow is adjusted at all other points.

41. The furrow wall will break badly if the coulter is not set properly "to land." To avoid furrow-wall-breaking in loose soils, try setting the coulter blade well forward and deep.

42. In plowing very hard ground, the coulter may have to be raised from standard set and moved back slightly on all types of plows except two-wheeled tractor plows which carry rigid hitches. On the latter, move the coulter ahead if possible. In plowing where flat stones abound, it often becomes necessary to set the coulter well ahead and to the full depth of the furrow.

43. In deep plowing, or in plowing where heavy trash abounds, coulters often must be run higher than the standard set provides for, in order to prevent trash from dragging at the bearing and shank, and to permit the coulter to mount the trash. This adjustment involves size of coulter blade as well as set. To cut through trash, a coulter must have something to cut against; the soil furnishes the resistance. But before the coulter can cut, it must get hold of the trash—it must mount the trash instead of pushing it ahead. Hence, for any trash condition, the coulter must be high enough to have good mounting ability, yet low enough to encounter

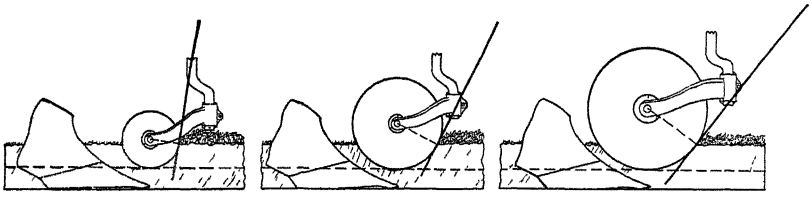


Fig. 12.—Large coulters can mount trash more readily than small ones

sufficient resistance against which it can cut through the trash. Also, it should be low enough to leave a clean-cut, sharp furrow-wall. Obviously, a large coulter blade set 4 inches deep will have better mounting ability than a small blade set at the same depth, as shown in Fig. 12. Or, the larger the blade, the deeper it can be set and yet maintain trash-mounting ability.

These points are of vast importance in plowing for corn borer control. The tendency is to use larger rolling coulter blades. One of the great difficulties with the old rolling coulters at present on all types of plows is that many of them are worn back to small diameters, some less than 10 inches. To successfully handle heavy trash, use a standard rolling coulter blade as large as conditions will permit, one of these conditions being that you must maintain sufficient clearance between the blade and other parts of the plow. If possible use 14- or 16-inch blades, and even 18-inch blades on the wider bottoms. Of course, a small coulter may have better pene-

trating ability than a large one in hard ground, and it may roll faster than the large one, yet the effectiveness of the rolling action in cutting trash depends largely on the blade getting hold of the trash. A moment's reflection on these principles will indicate the necessity of keeping both large and small coulters sharp.

44. Keep coulters sharp with a good, flat, mill file of about 12-inch size. Sharpening on an emery is often resorted to, but be careful not to bear on so hard or turn the emery so fast that you draw the temper of the blade. Take care of the coulter bearing, or repair it, to prevent wobbling. Some coulters carry cone bearings which can be drawn up slightly as wobbling develops due to wear. When working, the rolling coulter should stand vertically. If it runs at an angle from the vertical, trouble is almost sure to result. This has foiled many good plowmen. Watch for a badly worn bearing, a bent yoke, a bent shank, or excessive play between the yoke and shank.

45. **Combination Jointer and Coulter.**—Although not common on walking plows, the combination of jointer and rolling coulter is so advantageous for trash handling that a special, light combination is making its appearance for walkers. The advantages of the jointer (see par. 34) can be enjoyed in heavy trash if the jointer is accompanied by the cutting action of the rolling coulter.

46. When the coulter and jointer are used at the same time, standard rules for jointer set (See par. 35.) and standard rules for coulter set (See par. 40.) are followed as closely as possible, except that the coulter may have to be set slightly forward and the jointer set back, in order to give trash clearance between the jointer and the coulter bearing. Be sure to keep the point of the jointer very close to the blade of the coulter in order to avoid trash catching. Ordinarily, the clearance between the shin of the jointer and the coulter blade increases from zero at the point of the jointer to about $\frac{3}{8}$ inch at the top of the jointer shin. Do not discard the jointer simply because it catches trash when used with a wobbling coulter; repair the coulter. See also paragraphs 41 to 44.

SPECIAL COVERING DEVICES

47. **Chain.**—Probably the most common auxiliary covering device used on walking plows is the log chain. One end of the chain is fastened to the doubletree at the furrow horse's clevis. The other end is fastened to the plow beam at the jointer shank, where the handle braces attach to the beam, or at a point on the beam about 10 inches back of a vertical line through the point of the share. The chain is long enough to form a loop which drags on the surface

of the turning furrow slice. In this position the loop keeps trash from pitching, it helps straighten the trash, and folds it under as the slice is inverted. A little experimenting may be necessary to determine the exact points at which to fasten the chain and its proper length for the conditions at hand. Some operators lengthen the chain until its loop is pinched slightly by the falling furrow slice. Others tie a simple knot in the chain at the low side of the loop in order to have the chain held properly. Sometimes a short piece of wire is fastened to the chain at such point that the wire, in dragging under the turned slice, will hold the chain in the desired position. The chain is very valuable in fairly high, fast trash; it is often a great help in stubble. It may assist materially in twisted, whole corn stalks; but under this latter condition it should be accompanied, if possible, by other covering devices such as jointer or coulter. The chain can be used on single-bottom riding and tractor plows, although on wheeled plows, especially gangs, covering wires usually are used in place of chains.

48. **Covering Wires.**—The covering wire as an auxiliary covering device is not usually advocated for walking plows, because, unless care is used in its attachment, the wire tends to pull the walker from its normal position. The wire, however, has considerable merit, and there is opportunity for its wider adaptation to walking plows, especially in combination with the chain, the jointer, or the coulter. Try it. It may be just the thing for your particular conditions even though your neighbor may not like it.

49. The covering wire is simply a piece of No. 9 wire from 6 to 8 feet long for walkers and from 9 to 10 feet long for wheeled plows, the length depending on the point at which the wire is to be fastened to the plow. One end is fastened to the plow ahead of the plow bottom at such a point as will permit the wire to drag across the surface of the furrow slice just as the slice is being turned by the plow bottom. The other end of the wire drags under the newly turned slice. The weight of the turned slice holds the wire tight. When properly placed, the wire holds the trash tight against the turning furrow-slice—keeps the trash from pitching—and materially aids in folding the trash under. If the wire is not held tight enough, supply one a little longer, or bend up the rear end just a trifle. Do not bend the end enough to catch trash; do not put a hook in the end. If the wire breaks, supply a new one. Do not splice at any point where trash can catch.

50. When the rolling coulter is used alone, or in connection with the jointer, a good way of attaching the wire is shown in Fig.

13. Notice that the wire passes over the coulter bearing, inside the arm of the yoke, out the underside of the yoke, and up to the beam. The forward portion of the wire helps feed trash down below the coulter shank. Sometimes the wire is fastened directly to the coulter yoke close to the coulter bearing; sometimes to the lower end of the coulter shank. When the jointer is used alone, or when neither rolling coulter nor jointer is used, the wire is usually fastened to the beam just back of the plow bridle. Some plowmen clamp a piece of strap iron around the beam, the strap extending downward from a point approximately over the point of the share; the wire is fastened to this. The strap can be bent slightly, raised or lowered, or moved forward or backward until the best position is determined. Sometimes two or even three wires per plow are used.

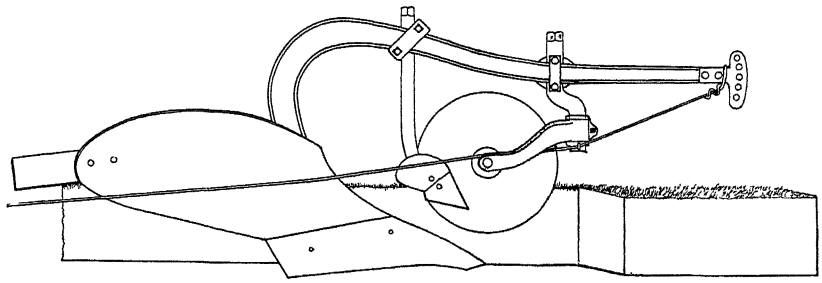


Fig. 13.—A good method of attaching a covering wire. Note also the moldboard extension, or "flipper."

Five wires per plow bottom have been used on tractor gang plows, the wires being fastened to a strap iron clamped well forward on the underside of the beams. In plowing for corn borer control, the covering wire is extremely important. Under some conditions it means the difference between good and poor trash covering. Its position and use vary with conditions. Get clearly in mind its function as described in paragraph 49. Then experiment with it systematically and patiently until you determine fully just how to place it.

51. Weed Hook.—The use, shape, position and adjustment of weed hooks is familiar to most plowmen. Ordinarily the weed hook does not rank in importance with the covering devices mentioned above. Some farmers, however, are imitating the weed hook by clamping to the beam a heavy piece of band iron, similar to wagon tire stock. The iron has a shape very similar to that of a weed hook, and is so placed that it draws the trash ahead slightly and folds it under just as the furrow slice lays over.

52. Moldboard Extension.—The moldboard extension, shown at the wing of the moldboard in Fig. 13, under some conditions is very valuable in laying the furrow slice over farther, and thus help-

ing to bury trash deeper in the creases. The moldboard extension, or "flipper," is becoming quite common on wheeled plows. Plows are appearing on the market with the holes already drilled in the moldboard for the attachment of the extension. Although the extension is not often used in this country on walking plows, nevertheless, there is opportunity for it. If your walker or wheeled plow carries a cast moldboard which is not drilled for the extension, you should not attempt to drill it. There is some possibility of drilling a steel moldboard, but this should be done only by a competent blacksmith or machinist, who is familiar with the handling and treatment of plow steels. The extensions can be purchased as extras. They are adjustable. A sample can be seen in nearly any dealer's store where tractor plows are sold.

RELATIVE VALUE OF COVERING DEVICES ON WALKING PLOWS

53. Conditions vary so widely in both stubble plowing and whole stalk plowing that no set rules can be given as to the effectiveness of the different covering devices described above, or of the combinations of such devices. The plowman should familiarize himself with the possibilities of each, and then use those which are best for his conditions. Thus far, however, experience in the corn borer area around Lake Erie indicates that accessories and covering devices on walkers are listed briefly below. The suggestions are given in a descending order of importance for average conditions. In reading these lists, the reader should keep in mind the possibilities of the moldboard extension, of using wires instead of the chain, or of using wires in addition to the other covering devices.

COMPARATIVE VALUE OF COVERING DEVICES

In short stubble	In high stubble	In whole stalks
1. Combination jointer and rolling coulter, chain	1. Combination jointer and rolling coulter, chain	1. Combination jointer and rolling coulter, chain
2. Combination jointer and rolling coulter	2. Jointer and chain	2. Rolling coulter and chain
3. Jointer and chain	3. Combination jointer and rolling coulter	3. Jointer and chain
4. Jointer	4. Rolling coulter and chain	4. Combination jointer and rolling coulter
5. Rolling coulter and chain	5. Chain	5. Rolling coulter
6. Rolling coulter	6. Jointer	6. Chain
7. Chain	7. Rolling coulter	7. Jointer

INDEX OF WALKING PLOW TROUBLES

COMMON CAUSES AND REMEDIES

54. Plow tends to run too deep.

1. Hitch too high. (See par. 26.)
2. Traces too long. (See par. 29.)
3. Too much down-suck, if repointed or resharpened share has just been put on. (See par. 18.)
4. If this trouble appears suddenly in a steel beam plow, the beam may have been bent upward. A bent beam should be straightened only at the factory or by a competent blacksmith.

55. Plow tends to run too shallow or fails to hold its depth.

1. Dull share. (See pars. 22 and 23.)
2. Other causes just the reverse of those given in paragraph 54.
3. Dull coulter. (See par. 44.) If rolling coulter is keeping the plow from its depth, see paragraphs 42 and 44.

56. Plow tends to run too wide.

1. Hitch too far toward plowed ground. (See par. 31.)
2. Too much lank-suck. If repointed or resharpened share has just been put on. (See pars. 18 and 19.)
3. Too little wing bearing. (See pars. 20 and 21.)
4. Stationary coulter may lead toward unplowed ground. (See par. 37.)
5. If this trouble appears suddenly in steel beam plow, the beam may have been bent toward the furrow. (See point 4, par. 54.)

57. Plow tends to run too marrow.

1. Dull share. (See pars. 22 and 23.)
2-5. Other causes just the reverse of those given in paragraph 56.
6. Auxiliary covering devices may pull plow toward furrow.

58. Plowman has to bear down on both handles. (See par. 54.)

59. Plowman has to raise up on both handles. (See par. 55.)

60. Plowman has to raise up on furrow handle and bear down on land handle. (See par. 56.)

61. Plowman has to raise up on land handle and bear down on furrow handle. (See par. 57.)

62. Plow does not run steady under good plowing conditions.

1. Down-suck or land-suck wrong. (See pars. 17, 18, and 19.)
2. Wing bearing wrong. (See pars. 20 and 21.)
3. Dull share. (See pars. 22 and 23.)
4. Hitch wrong. (Set pars. 24 to 33.)
5. Coulter trouble. (See pars. 37 to 44.)
6. Share loose.

63. Furrow-wall breaking.

1. Jointer or coulter set wrong. (See pars. 37 to 46.)
2. Badly worn shin. (The shin of a plow is the part which cuts the furrow slice loose vertically when no jointer or coulter is used.) If your plow carries a renewable shin-piece, supply new one.
3. Land-suck wrong. (See pars. 17, 18, and 19.)
4. Wing bearing wrong. (See pars. 20 and 21.)
5. Dull share. (See pars. 22 and 23.)

64. **Failure Properly to Cover Trash.**

1. Relation of depth and width of plowing to width of plow bottom. (See pars. 10 and 11.)
2. Speed. (See par. 14.)
3. Badly worn wing of mold (the wing of the moldboard is the tip of the mold on the plowed ground side).
4. Plow not running steady, or not in proper position in relation to furrow slice. (See par. 62.)
5. Jointer or coulter set wrong. (See pars. 37 to 46.)
6. Absence of auxiliary covering devices. (See pars. 47 to 52.)
7. Nonscouring. (See par. 127.)
8. If poor trash covering or poor granulation has always been a trouble with your plow bottom for your particular condition, do the best you can with it, according to the suggestions herein, until you are ready to purchase a new plow. Then take the matter up with manufacturers; their suggestions as to shapes of molds may quickly solve your difficulties.

65. **Failure to properly granulate the furrow slice.** Review all points suggested in paragraphs 62 and 64.

66. **Nonscouring.** (See par. 127.)

67. **Excessive Draft.**

1. Dull share. (See pars. 22 and 23.)
2. Coulter set wrong, or dull. (See pars. 37 to 44.)
3. Hitch wrong. (See pars. 24 to 33.)
4. Too much down-suck or lank-suck. (See pars. 17 to 19.)
5. Nonscouring. (See par. 127.)
6. Absence of coulter.
7. Badly worn shin. (See point 2, par. 63.)

68. **Sore hips, sore necks, choking, and chafed bellies of horses.** (See par. 29.)

LOW-LIFT (FRAMELESS), SULKY, HORSE PLOWS

A low-lift, or frameless, sulky plow for use with horses, is a single-bottom riding plow in which the wheels are attached directly to the beam. The beam is raised and lowered on the land wheel and on the front furrow wheel by means of levers. Ordinarily the relationship between the beam and rear furrow-wheel is set and cannot be changed. This feature, together with the absence of an extra frame, renders implement a "low-lift" or "frameless" plow.

69. Width of Cut.—The front furrow-wheel is supposed to run in the angle between the furrow wall and bottom of the open furrow. It is partly a guide which helps hold the plow to its width. Fig. 14 shows how to determine the width of cut for which a one-way, wheeled plow is set. Lower the plow bottom to the floor or ground; level the plow; set the front furrow-wheel to lead straight; place a board or a straight edge tight against the point of the share and against the rear furrow-wheel. The distance from the inside of the rim of the front furrow-wheel to the straightedge will be approximately ½-inch less than the width the plow will take when it

is working. This assumes that the front furrow-wheel will be properly angled according to the hitch, as described under Hitch, page 29, and that the plow is used on fairly level ground. If you want the plow to plow wider, move the wheel farther away from the beam; if narrower, closer to it, by the adjustment for this purpose such as at W in Fig. 14. Unless you are attempting to throw furrow slices up or down hillsides, do not attempt to control width of cut by angling the front furrow-wheel. Setting the front furrow-wheel to lead toward or away from the furrow wall is primarily for the purpose of holding the plow straight according to the hitch (See par. 77).

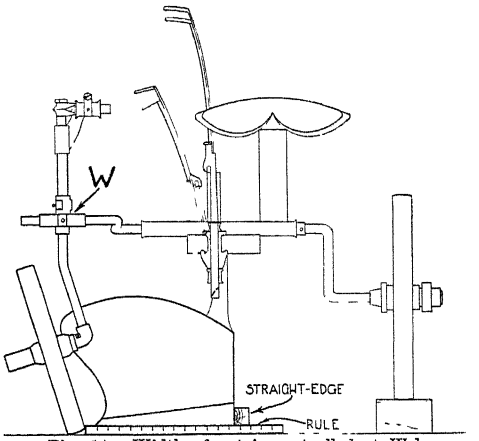


Fig. 14.—Width of cut is controlled at *W* by moving the front furrow wheel nearer to or farther from the beam.

70. The proper running of the low-lift sulky depends largely on securing and maintaining the proper down-suck, land-suck, wing fullness, sharpness, levelness, hitch, angle of front furrow-wheel, and the set and condition of jointer, coulter, and special covering devices.

71. Down-suck and Land-suck.—That part of the total down-suck and land-suck which is under the control of the operator is that part which is built into the share itself. Read carefully paragraphs 18 and 19.

72. Wing Fullness.—Inasmuch as the down thrust of a riding-plow bottom is carried on the wheels, instead of on the heel of the landside and on the wing of the share, no wing bearing is necessary on riding plows. However, in repairing shares, care should be taken to keep the share full at the wing, and to avoid putting in the wing bearing described in paragraph 21.

73. Sharpness (See pars. 22 and 23).

74. Levelness.—In one-way, wheeled, horse plows, the front furrow-wheel lever is known as the depth lever, and the land-wheel lever is a leveling lever. After the backfurrow has been thrown and the desired depth of plowing secured, the front furrow-wheel must run on the same plane as the cutting edge of the share, and the plow bottom, bottoms, or frame, crosswise, must be kept level (parallel to the surface). If these sets are not maintained in proper relation to one another, the plow bottom will not be held in

its normal position in respect to the furrow slice. Poor turning, poor granulation, and poor trash covering are likely to result. A plowman can gradually increase depth of plowing from furrow to furrow by simply letting the bottom down a little by the land-wheel lever. He may decrease depth by raising the bottom in respect to the land-wheel. This is the easy way and the common method on tractor plows. It is perfectly permissable, if no ill effects result. But if poor covering of trash occurs while the plow is finding its new depth, the operator will do better to secure his new depth quickly by using both levers, then readjust the front furrow-wheel after he has completed one round of the land.

75. By lowering the land-wheel and raising the furrow-wheel, or vice versa, some wheeled plows of both the horse and tractor types can be run "winged down," or "winged up," and still maintain their depth. The plow soles of adjacent furrows then form a saw-tooth shaped surface under the turned furrow slices. These sets are sometimes resorted to where nonscouring cannot be overcome by any other means. Sometimes, in very hard ground, a wheeled plow is run low on the land-wheel to offset the tendency of the plow to "ride" up. Sometimes, in very soft ground, a wheeled plow is run high on the land-wheel (or the frame is kept level and the front furrow-wheel is set lower than the front share) to offset the tendency of the plow to "ride" deeper each trip. But, for reasons stated in the preceding paragraph, these sets should not be resorted to unless absolutely necessary.

7. **Hitch (Vertical).**—The tendency of plowmen with all wheeled plows is to hitch too high. This tends to throw the plow "on its nose"; to take weight off the rear furrow-wheel, causing the plow to weave in the furrow. Draft will be increased because the broken line of hitch will increase the load on the forward wheels. If the hitch is too low, penetration may be affected, the horses may suffer too much down pull on their collars, and some of the normal load on the forward wheels will be transferred to the rear wheel. Keep the plow bottom in proper condition, as described in the preceding paragraphs; then keep the line of hitch in the vertical plane straight, as described in paragraphs 24 to 28, and illustrated in Fig. 7. To inspect for proper height of hitch, stop the plow while the plow bottom is at its proper depth; standing in front of the team and between the furrow horse and first land horse, sight from the horses' hame hooks to a point which represents the center of resistance of the plow bottom. (See par. 24.) If the point of attachment of the team to the plow bridle falls in your line of vision, the

height of hitch is approximately correct for normal plowing condition when the bottom is in good shape. Another method of testing for height of hitch is to see that the down thrust of the plow is divided fairly evenly between the three wheels, with slightly less weight on the rear furrow-wheel.

77. Hitch (Horizontal), and Angle of Front Furrow-Wheel.—Glancing at Fig. 15, get well in mind that the true line of draft of a one-bottom plow is an imaginary line parallel to the open furrow and passing through the center of load. This center of load, or center of resistance (See par. 24), is approximately 2 inches from the shin of the plow bottom. Sidedraft[1] is sure to result when three horses are driven abreast on a common size, one-bottom, wheeled plow, and when one of the outside horses walks in the open furrow.

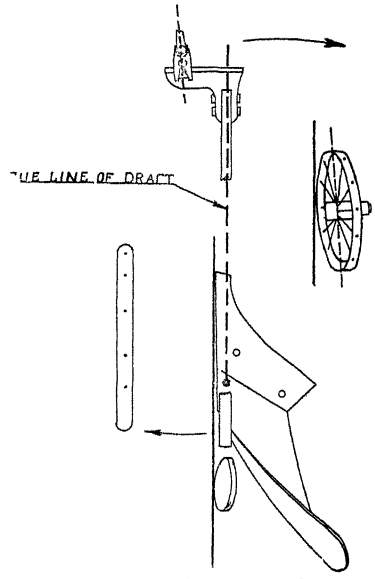


Fig. 15.—Not ce the angle of the front furrow-wheel when the center line of pull of team is on the unplowed ground side of the true line of draft of the plow.

This sidedraft occurs because the center of the team is farther from the open furrow than is the true line of draft of the implement. In order to keep the line of hitch (Fig. 11) as straight as possible, the clevis must be attached to the plow bridle on the unplowed ground side of the true line of draft as shown in Fig. 15. This causes the land horses (Fig. 11) to pull at a slight angle to the open furrow. It also tends to force the front of the plow slightly toward the plowed ground, as indicated by the arrow in Fig. 15, just as the front of a stoneboat will shift if you hitch off center and yet keep the rear in line. Angle the front furrow-wheel to lead slightly toward the furrow wall just enough to offset the tendency of the front of the plow to shift out. Do not angle it so much that the wheel tends to climb the furrow wall; yet enough to run lightly against the wall. This adjustment is important. It enables the plow to absorb its share of the sidedraft; yet it holds the plow in position for best work. If rear furrow-wheel is adjustable, see paragraphs 88 to 94.

[1] In this presentation the following simple interpretation is used: *Sidedraft* in an outfit is the increase in the resistance of a load (due to the point of attachment of the prime mover to the load being at one side of the true line of draft), and the loss of power (due to the point of attachment of the load to the prime mover being at one side of the true line of pull.)

78. Many plowmen can plow cheaper, better, and deeper by using four horses, instead of three, on one-bottom, one-way, wheeled plows. Four horses are especially advantageous in fall plowing. With the four horses abreast, however, the sidedraft in both team and plow is excessive and highly objectionable. The horses should be driven tandem, two ahead of two. Then, if the proper length of doubletree is used on the rear two, sidedraft can be eliminated, the horses can walk straight, they will be spread for hot weather work, the plow can assume its normal position for best work, and better speed can be maintained. (See par. 14.) In arranging such tandem hitch, get the center of pull of the team the same distance from the center of the open furrow as the true line of draft of the plow. Then no sidedraft should exist, and the front furrow-wheel should be set to run straight. If the clevis has to be attached to the plow bridle on the unplowed-ground side of the true line of draft, set the front furrow-wheel to lead toward the wall as described in paragraph 77.

If the clevis has to be attached to the bridle on furrow side of the true line of draft, angle the front furrow-wheel to lead slightly away from the furrow wall. When a single bottom plow is cutting its normal width, its true line of draft will be approximately 16 inches from the center of the open furrow with a 12-inch plow; 19 inches with a 14-inch plow; 22 inches with 16-inch plow, and 25 inches with an 18-inch plow. Or, for all practical purposes, the distance in inches from the true line of draft of the plow to the center of the open furrow, where the furrow horse walks, is one and one-half times the width of cut minus 2 inches.

79. **Jointer.** (See pars. 34 to 36.)

80. **Coulter.** (See pars. 37 to 44.)

81. **Combination Jointer and Coulter.** (See pars. 45 and 46.)

82. **Special Covering Devices.** (See pars. 47 to 52.)

RELATIVE VALUE OF COVERING DEVICES ON RIDING PLOWS

See paragraph 53, and in the table therewith substitute covering wires for chain.

INDEX OF LOW-LIFT, SULKY PLOW TROUBLES
COMMON CAUSES AND REMEDIES

Use index given on page 37.

HIGH-LIFT (FRAMED), SULKY, HORSE PLOWS

A high-lift, or framed, sulky plow, for use with horses, is a single-bottom riding plow in which a special frame forms the backbone. All three wheels attach directly to the frame, instead of to the beam, and by means of a foot lift and bails, the plow bottom and its beam are raised and lowered within the frame. The frame feature permits the plow bottom to be raised in respect to the rear furrow-wheel; this renders the implement a "high-lift," or "framed" plow.

83. **Width of Cut.**—See paragraph 69 and Fig. 16. The common adjustment to control width of cut of high-lift horse sulkies, and to control the width of cut of the front plow base of horse gang plows, is shown at W in Fig. 16. Move the front furrow-wheel sleeve casting in for a narrower cut; for a wider cut, move it out.

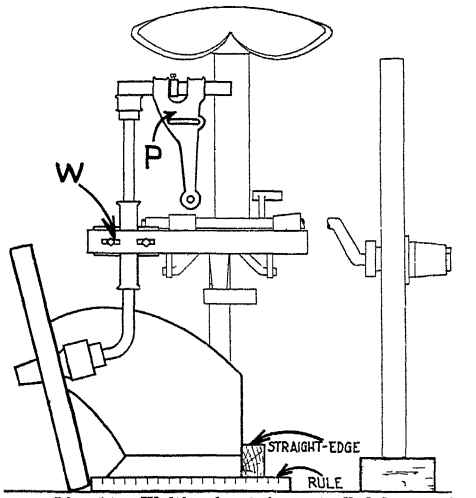


Fig. 16.—Width of cut is controlled by moving the front furrow-wheel in or out at *W*; not by angling the wheel at *P*.

84. The proper running of a high-lift sulky depends largely upon securing and maintaining the proper down-suck, land-suck, wing fullness, sharpness, landside clearance, heel clearance, levelness, hitch, angle of front and rear furrow-wheels, and upon the set and conditions of jointer, coulter, and special covering devices.

85. **Down-Suck and Land-Suck** (See pars. 18 and 19).

86. **Wing Fullness** (See par. 72).

87. **Sharpness** (See pars. 22 and 23).

88. **Landside Clearance.**—Most high-lift horse sulkies and horse gang plows carry a landside on the plow bottom directly ahead of the rear furrow-wheel. The rear furrow-wheel should run tight against the furrow wall. Three-eighths inch clearance, or a close "finger's width," should exist between the landside and furrow wall as indicated in Fig. 17, which shows also a common adjustment by which this clearance is maintained. As a plow ages, wear between the rear furrow-wheel standard and the sleeve casting, and sometimes wear in the rear furrow-wheel parts, permit the plow bottom

to shift over (in respect to the rear furrow-wheel) until the landside rubs against the furrow wall. Then the draft is increased, the plow bottom is not held in its normal position, furrow-wall breaking may occur, and the total land-suck of the plow is lessened. (See par. 90.) Move the plow frame on the rear furrow wheel assembly until the proper clearance is secured. Landside clearance in high-lift plows for horse use should be maintained by the position of the rear furrow-wheel in respect to the frame; not by angling the rear furrow-wheel horizontally. (See Angle of Furrow Wheels, par. 93.)

89. Heel Clearance.—As the down thrust of the plow should be carried on the wheels, the heel of the landside on three-wheeled, high-lift, horse plows should not "ride" the bottom of the furrow. A clearance of 3/8 inch, or a close "finger's width," should exist between the heel of the landside and the bottom of the furrow, as indicated in Fig. 17, which shows also by arrow a common adjustment to maintain heel clearance. By this type of adjustment, the plow frame can be raised or lowered slightly in respect to the rear furrow-wheel. For heel clearance, some plows carry an adjustment by which the rear of the plow beam can be raised or lowered slightly in respect to the frame. Heel clearance is very important. If it is not properly maintained, the plow bottom will not be carried in normal position and the total down-suck of the plow may be seriously upset. (See par. 90.)

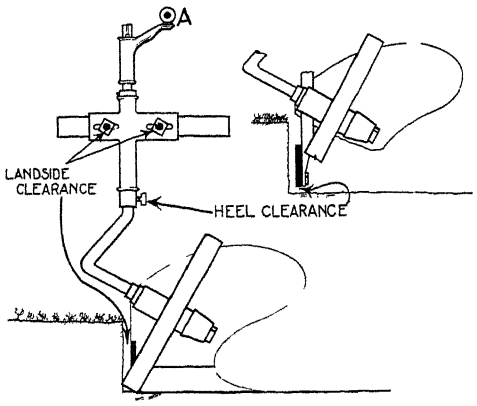


Fig. 17.—Proper heel clearance and landside clearance is easy to maintain

90. Obviously, the tendency of the plow to "suck" to a greater width of cut is influenced by landside clearance (see par. 88) as well as by the land-suck which is built into the share itself. (See Fig. 3.) Likewise, the tendency of a plow to "suck" into the ground is influenced by heel clearance (See par. 89) as well as by the down-suck which the share itself carries. (See Fig. 2.) Too much emphasis, however, cannot be placed on the warning: Do not increase either the landside clearance or the heel clearance simply to make up for the shortcomings of a dull share. If you do, the plow will not run correctly, and excessive draft will result. Maintain the proper land-suck and down-suck in the share itself (See pars. 18 and 19) then

maintain the proper landside clearance and heel clearance as described in paragraphs 88 and 89.

91. Levelness. (See pars. 74 and 75.)

92. Hitch (Vertical).—(See par. 76.) On single bail, high-lift, horse plows, hitch at such height as to permit the back end of the beam to float properly within the "limits casting" when the plow is run locked into the ground.

93. Hitch (Horizontal), and Angle of Front and of Rear Furrow-Wheels.—When three horses are driven abreast on a high-lift sulky, with one of the outside horses walking in the open furrow, angle the front furrow-wheel to lead slightly toward the furrow wall as described in paragraph 77. This is accomplished by the adjustment in the pole plate P in Fig. 16, or by a little landing lever at the top of the front furrow-wheel standard. Inasmuch as the rear of the plow tends to shift toward the unplowed ground, as indicated by the arrow in Fig. 18, set the rear furrow-wheel to lead away from the furrow wall as shown. This is accomplished by an adjustment A in Fig. 17 in the connecting rod which runs from the rear to the front furrow-wheel. Angling the furrow-wheels properly in the horizontal plane accommodates the plow to the hitch. Ordinarily, angling should not be used to control width of cut (See par. 69), or to control landside clearance (See par. 88).

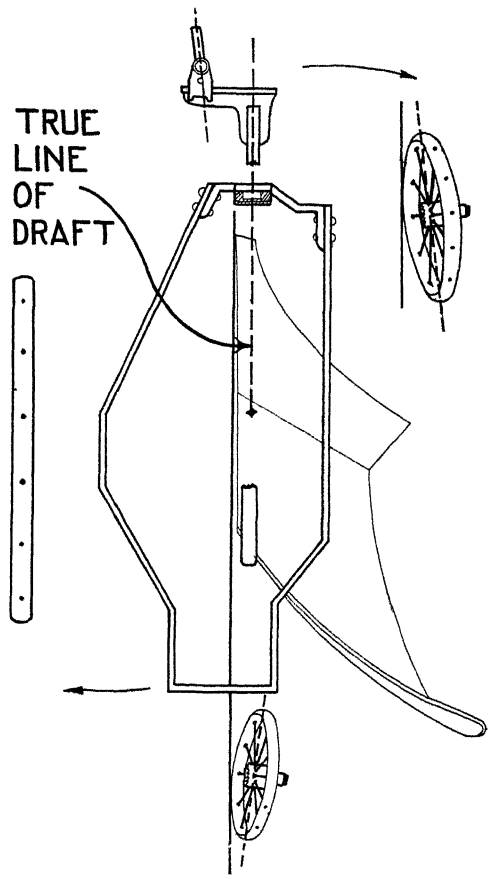


Fig. 18.—How to angle the furrow-wheels of a high-lift plow when the center line of pull is on the unplowed ground side of the true line of draft

94. For four horses on high-lift sulkies, see paragraph 78. If center of pull of the team is over the true line of draft of the plow, when four horses are driven tandem, set the front furrow-wheel to

run straight and the rear furrow-wheel to lead very slightly away from the furrow wall. If the center of pull is on one side of the true line of draft of the plow, set the front furrow-wheel to lead as stated in paragraph 78, then set the rear furrow-wheel to lead in the opposite direction from that of the front wheel. How much the wheels should "lead" depends upon conditions. The greater the distance between the center of pull and true line of draft, the more the wheels must be angled. Do not angle them more than necessary. If either one tends to climb the furrow wall, or tends to "hook-up" or crush into the furrow wall, set it at a lesser angle and seek further relief in the hitch.

95. Jointer. (See pars. 34 to 46.)

96. Coulter. (See pars. 37 to 44.)

97. Combination Jointer and Coulter. (See pars. 45 and 46.)

98. Special Covering Devices. (See pars. 47 to 52.)

RELATIVE VALUE OF COVERING DEVICES ON SULKY PLOWS

See paragraph 53, and in the table therewith substitute covering wires for chains.

INDEX OF HIGH LIFT, SULKY PLOW TROUBLES

COMMON CAUSES AND REMEDIES

Use index given on page 37.

HIGH-LIFT (FRAMED), GANG PLOWS FOR HORSES

A high-lift, or framed, gang plow for use with horses is a riding plow, containing more than one plow bottom, in which a special frame forms the backbone. All three wheels attach directly to the frame instead of to the beam. By means of a foot-lift and bails, the plow bottoms and their beams are raised and lowered as a unit within the frame. The frame feature permits the bottoms to be raised in respect to the rear furrow wheel; this renders the implement a "high-lift," or "framed" plow.

99. The proper running of the high-lift, gang plow for horse use depends largely upon securing and maintaining the proper down-suck, land-suck, wing fullness, sharpness, landside clearance, heel clearance, width of cut of front plow bottom, levelness, hitch, angle of front and rear furrow-wheels, and the set and condition of jointer, coulter, and special covering devices.

100. Down-suck and Land-suck. (See pars. 18 and 19.)

101. Wing Fullness. (See par. 72.)

102. Sharpness. (See pars. 22 and 23.)

103. Landside Clearance.—Refers to clearance between the furrow wall and the landside of the rear bottom. (See pars. 88 and 90.)

104. Heel Clearance.—Refers to clearance between the bottom of the furrow and the heel of the landside of the rear bottom. (See pars. 89 and 90.)

105. Width of Cut of Front Bottom.—(See par. 83 and Fig. 16.) Secure the proper width of cut of the front plow bottom by moving the front furrow-wheel sleeve casting toward the beam or away from the beam by the adjustment W in Fig. 16. Width of cut should be secured by this adjustment and not by angling the front furrow-wheel. Ordinarily, the front plow bottom of gang plows is

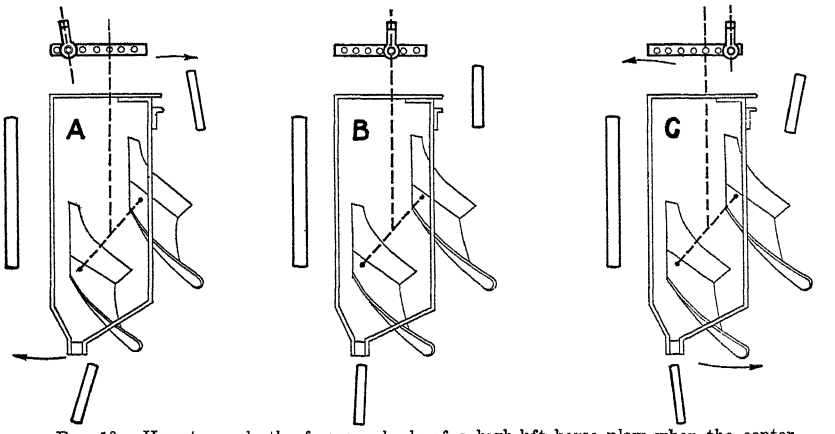


Fig 19.—How to angle the furrow-wheels of a high-lift horse plow when the center line of pull is on the unplowed ground side, or on the furrow side, or over the true line of draft.

the only one of which the width of cut can be changed. If the front plow bottom does not cut the same width as the others, uneven furrow crowns may result.

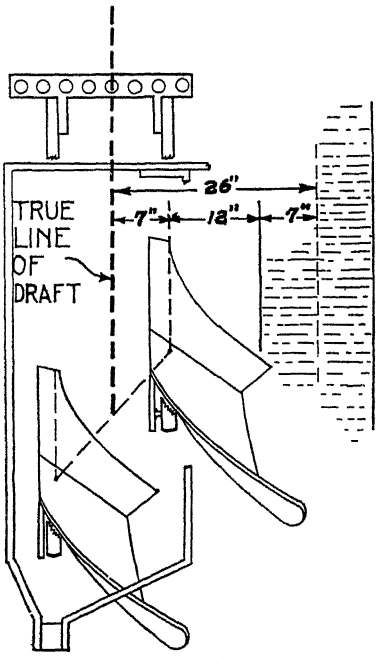
106. Levelness. (See pars. 74 and 75.)

107. Hitch (Vertical). (See par. 76.)

108. Hitch (Horizontal) and Angle of Front and Rear Furrow-Wheels.—When four horses are driven abreast on a two-bottom gang plow, with one of the outside horses walking in the open furrow, sidedraft is sure to exist to a rather marked and objectionable degree. If the horses must be driven abreast, set the furrow-wheels to lead in the directions indicated in A, Fig. 19. The reasons for these sets are given in paragraphs 77 and 93.

109. When four, five, or six horses are used on a gang plow, they should be driven tandem so that the center line of pull from the team can be brought as close as possible to the true line of draft

of the plow. (See pars. 77, 78, 93, and B, Fig. 19.) If the two lines coincide, the sidedraft effects will be eliminated from both the team and plow; draft will be reduced; power will be saved; the horses can pull straight forward; they will be spread better for hot weather work; the plow can handle the furrow slice and trash better, because it can work in its normal position, and better speed can be maintained. If the tandem hitch is used, set the furrow-wheels to lead in the directions indicated in Fig. 19, according to how far the center line of hitch is from the true line of draft of plow, and according to which side of the latter the former falls. Be careful not to get confused between right and left hand plows.



F.g. 20.—Pertinent distances used to find how far true line of draft is from center of open furrow. Distances given in illustration are those for a 14-inch gang.

110. Fig. 20 shows how to calculate the distance from the true line of draft to the center of the open furrow, and gives this distance for a two-bottom, 14-inch gang. The center of the open furrow is used as the base from which to measure, because the center of the furrow horse is the base from which the team distances are taken in designing hitches. The following table gives approximate distance from the true line of draft of the plow to the center of the open furrow when various sizes of horse gang plows are used:

Number of bottoms per gang	Width of each bottom	Distance from true line of draft to center of open furrow
	Inches	*Inches*
2	12	22
	14	26
	16	30
	18	34
3	12	28
	14	33
	16	38
4	12	34
	14	40

111. **Jointer.** (See pars. 34 to 36.)

112. **Coulter.** (See pars. 37 to 44.)

113. **Combination Jointer and Coulter.** (See pars. 45 and 46.)

114. **Special Covering Devices.** (See pars. 47 to 52.)

RELATIVE VALUE OF COVERING DEVICES ON HORSE GANG PLOWS

115. See paragraph 53 and in the table therewith substitute covering wires for chains. Remember, however, that excessive clogging in heavy trash is apt to occur when the jointer is used in combination with the rolling coulter on the narrow widths of gang plows. The 12-inch gang usually gives more trouble in this regard than the 14-inch gang. On these two sizes of gangs, particularly the 12-inch, the rolling coulter without jointer often will be found more advantageous than the combination of the two.

INDEX OF TROUBLES OF THREE-WHEELED HORSE PLOWS

COMMON CAUSES AND REMEDIES

116. **Failure to penetrate.**

1. Dull share. See pars. 22 and 23.)
2. Not proper amount of down-suck and land-suck. (See pars. 18 and 19.)
3. Hitch too low. (See par. 76.)
4. Not proper amount of heel clearance. Refers to high lift plows only. (See pars. 89 and 90.)
5. Dull coulter. (See par. 44.)
6. Rolling coulter too far forward in hard ground. (See par. 42.)
7. Nonscouring. (See par. 127.)
8. Lifting springs too tight in hard ground plowing.
9. See paragraph 118.

117. **Failure to hold width.**

1. Not proper amount of land-suck in share. (See pars. 18 and 19.)
2. Not proper amount of landside clearance. Refers to high-lift plows only. (See pars. 88 and 90.)
3. Front furrow-wheel angled wrong. (See pars. 77, 78, 93, 94, 108, and 109.)
4. See paragraph 119.

118. **Each furrow deeper or shallower than the one preceding, yet field conditions for plowing are good.**

1. Plow being run out of level. (See par. 74.)
2. Front furrow-wheel not on same plane as cutting edge of front share. (See par. 74.)
3. If ground is very hard, see paragraph 75.
4. See paragraph 116.

119. **Plow tends to run "twisted" at too great angle to open furrow.**

1. Hitch wrong, or furrow-wheels angled wrong, or excessive side draft. (See pars. 77, 78, 93, 94, 108, and 109.)

120. **Failure to properly cover trash.**

1. Plow not held in proper position relative to furrow slice. (See pars. 118 and 119.)
2. See paragraph 64.
3. Nonscouring. (See par. 127.)

121. **Failure to properly handle furrow slice and granulate.**

1. See paragraphs 118, 119, and 120.

122. **Furrow crowns not of equal height.** Highly objectionable from standpoint of uniformity in plowing and in granulation by subsequent tillage operations. Very common trouble with gangs.

1. Front bottom cutting wider or narrower than rear bottom. (See par. 105.)
2. Coulters not set alike.
3. Not same width or depth round after round.
4. Plow not level. (See par. 74.)
5. Land-wheel on corn row, or one bottom of gang is plowing corn row.
6. Badly worn bail boxes, wrenched frame, or frame loose in joints, letting front bottom sag lower than rear.
7. See paragraph 123.

123. **Furrow crowns not of equal curvature—not of similar shape.** Refers to gangs only.

1. See paragraph 122.
2. Plow bottoms not scouring alike.
3. One plow bottom loose on beam.
4. One beam bent, forcing one bottom out of normal position. (See par. 226.)

124. **Furrow wall breaking.**

1. Coulter or jointer set wrong. (See pars. 37 through 46.)
2. Badly worn shin. See point 2, under par. 63.)
3. Dull share. (See pars. 22 and 23.)
4. Not right amount of landside clearance. Refers to high-lift plows only. (See pars. 88 and 90.)
5. Hitch wrong, or furrow-wheels angled wrong, or excessive sidedraft. (See pars. 77, 78, 93, 94, 108, and 109.)
6. Not correct amount of land-suck in share. (See pars. 18 and 19.)

125. **Furrow-wheels climb furrow wall, break up furrow wall, or keep running away from furrow wall.**

1. Wheels angled wrong, or excessive sidedraft, or hitch wrong. (See pars. 77, 78, 93, 94, 108, and 109.)

126. **Excessive Draft.**

1. Too much down-suck or land-suck in share. (See pars. 18 and 19.)
2. Too much landside clearance or heel clearance. Refers to high lifts only. (See pars. 88, 89, and 90.)
3. Sidedraft, hitch wrong, or furrow-wheels set wrong. (See pars. 77, 78, 93, 94, 108, and 109.)
4. Coulter set wrong or dull. (See pars. 40 to 44.)
5. Nonscouring. (See par. 127.)
6. Absence of coulter.
7. Badly worn shin. (See point 2, par. 63.)
8. Poor lubrication of wheels.

127. **Failure to scour** (nonscouring).

1. Rusty moldboard. Remove rust with soft-baked brick, by kerosene and rag, or by plowing in a scouring soil until rust is removed. In removing rust, be very careful not to scratch steel moldboards. Avoid rust by greasing moldboards when they are to stand idle long.

2. Varnish on new moldboards. If you are to start the plow in a nonscouring soil, first remove the varnish with varnish remover or with a strong solution of lye and water. Do not let the lye solution remain long on the moldboard. Start the plow soon, or thoroughly wash off the solution.

3. Speed. The speed of plowing usually has a marked influence on scouring. Temporarily, plowing narrower (with single bottom plow) or shallower is sometimes resorted to in order to increase speed. (See par. 14.)

4. Wrong metal, or wrong shape of moldboard. If you have had trouble with nonscouring continuously, discuss with reliable manufacturers the advisability of using another shape of moldboard or another kind of plow metal.

5. High and low spots. If you are using a moldboard which constantly fails to scour, test for high and low spots. Resting the fingers lightly on the share, move your hand quickly from the share to the top of the moldboard. Repeat several times over different places on the mold. The surface should not have perceptible humps or depressions. Test further by close inspection after the plow bottom has taken on a good land-polish. The low spots will usually be dull, while the surrounding surface will be highly polished. A new moldboard is the only remedy for high and low spots.

6. Soft spots. In spite of the extreme care used by manufacturers to secure even tempering of plow parts, occasionally a moldboard with soft spots will reach the farmer. After the plow has been used some time, the soft spots develop into low spots similar to those in a warped surface described above. Soft spots will not scour readily in sticky soil. After a moldboard has been used a few hours, soft spots may be detected by their dull appearance. Or they may be found by the resistance they offer when the sharp corner of a broken file is run lightly by hand over the surface of the moldboard. A new moldboard is the best remedy.

7. Wrong amount of down-suck and land-suck in share. (See Pars. 18 and 19.)

8. Wrong amount of landside clearance and heel clearance. Refers only to high-lift plows. (See pars. 88, 89, and 90.)

9. Plow out of level. (See pars. 74 and 75.)

10. Poor fitting shares. Using the right kind and size of share has influence on scouring as well as on quality of work. Shares should fit properly and be drawn down tight. If the surface of the share is higher than the surface of the moldboard, nonscouring may begin by the soil sticking behind the share line.

11. Loose plow bottom. Plow bottoms on wheeled plows, particularly on tractor plows, often become loose on the beam. If this does not actually cause nonscouring it may produce a similar effect, especially in the shape of the crown of the furrow slice.

12. Excessive sidedraft. If so much sidedraft exists that the plow actually runs at an unusual angle to the open furrow, poor work, poor granulation, poor trash covering and nonscouring may result because the

wing of the moldboard has dropped back from its normal position. In respect to the furrow slice, the plow bottom has become of slightly milder shape. On horse riders, rearrange the team and hitch to lessen sidedraft, and to set furrow-wheels properly.

13. Wrong angle of furrow-wheels. (See pars. 77, 78, 93, 94, 108, and 109.)

14. Absence of land polish. A moldboard cannot be expected to scour properly until it has had opportunity to take on a good "land-polish." Keep working it, be patient, until it has had this chance.

15. Temporary adjustments to overcome nonscouring. The plow expert first will check up on all of the above points. Then, if a temporary adjustment must be resorted to until the soil condition changes enough to permit the plow to scour, the plow expert usually systematically seeks relief by trying the following adjustments in the order given. He tries only one at a time; if that does not help, he returns to the original or standard set before attempting the next adjustment. In connection with the following list, one should keep in mind the standard rule: Any adjustment which will increase the pressure of the furrow slice on the moldboard, usually will aid in eliminating nonscouring. Although this rule holds for many conditions, it is not infallible; occasionally, lessening the pressure helps.

A. Try coulters set a little more "to land." (See par. 40.)

B. Try plowing a little wider. Refers to single bottom plows.

C. Try plowing deeper. Having in mind soil productivity, do not drop more than 1 inch below the old plow-sole unless you are sure that no ill effects will result in your particular soil. If the old plow-sole is stickier than the surface, this adjustment cannot be used to overcome nonscouring.

D. Try plowing more shallow in order to increase speed.

E. Try setting coulters less "to land." (See par. 40.)

F. Try plowing more narrow. Refers to single bottom plows only.

G. Try running wheeled plow "winged down." (See par. 75.) Plow is as high on the land side as the distance which the front share runs below the bottom of the front furrow-wheel. Saw-tooth shaped plane of plow-sole results. This may be detrimental to proper furrow slice handling and trash covering.

H. Try running wheeled plow "winged up." (See par. 75.) Plow is as low on land side as the distance which the front share runs above the bottom of the front furrow-wheel. Saw-tooth shaped plane of the plow sole results. This may be detrimental to proper furrow slice handling and trash covering.

I. Try increasing landside clearance on high-lift plows. (See pars. 88 and 90.)

J. Try decreasing landside clearance on high-lift plows. (See pars. 88 and 90.)

K. Try removing coulter for short period.

L. Try increasing heel clearance on high-lift plows. (See pars. 89 and 90.) Will increase draft and may result in bobbing. (See par. 129.)

M. Try decreasing heel clearance on high-lift plows. (See pars. 89 and 90.) May result in loss of penetration. (See par. 116.)

128. **Shoving.** Sometimes in very loose, "fluffy" soils, the furrow slice breaks and pushes along in front of the plow instead of passing back on the moldboard. Do not confuse this trouble with nonscouring. Short or "cut-off" shares are used on wheeled plows to overcome this trouble.

129. **Bobbing, jumping, gouging.** Instead of holding steadily to its depth, the plow gouges along; sucks to its depth, then jumps up; "bobs."

1. Dull shares . (See pars. 22 and 23.)
2. Too much down-suck in share. (See pars. 18 and 19.)
3. Hitch too high (See par. 76).
4. Dull coulter, or coulter set too low or too far forward for hard ground conditions. (See pars. 42 to 44.)
5. Too much heel clearance on high-lift plows. (See pars. 89 and 90.)

130. **Plow comes up to lesser depth as it approaches the headland.** Because front wheel is ahead of plow bottom, front furrow-wheel raises plow as it rolls up the inclined plow sole approaching the headland. Offset this effect every three or four rounds by moving the front furrow-wheel lever and letting the front furrow-wheel rise on the frame while it is rolling up the incline.

131. **Dribble.** Constant stream of finely granulated soil drops down between the furrow wall and shin of the plow.

1. Coulter or jointer not set correctly. (See pars. 34 to 44.)
2. Proper landside clearance not maintained on high-lift plows. (See pars. 88 and 90.)
3. Rear bottom out of alignment due to bent beam. (See par. 226) or rear bottom loose.

3-WHEELED TRACTOR PLOWS WITH FULL FLOATING HITCH

In a plow of this type, which may have one, two, three or four bottoms, all three wheels carry the bottoms at all times. When the beams are raised and lowered they remain parallel to the surface of the ground because they are raised and lowered on the rear furrow-wheel as well as on the front wheels. To secure this lifting action on the rear furrow-wheel, a connecting rod, or lifting rod, runs to the rear furrow-wheel assembly from the lifting mechanism ahead. Such plows carry "full floating" hitch bars which float freely vertically. That is, the tractor and the plow are independent of one another in their up and down movement in passing over the rises and through the depressions of an uneven surface.

132. The proper running of this type of plow depends largely on securing and maintaining the proper down-suck, land-suck, wing fullness, sharpness, levelness, angle of rear furrow-wheel, landside pressure, heel clearance, length of connecting rod, width of cut, sidedraft relations, hitch, and set and condition of jointer, coulter, and special covering devices.

133. **Down-Suck and Land-Suck.** (See pars. 18 and 19.)

134. **Wing Fullness.** (See par. 72.)

135. **Sharpness.** (See pars. 22 and 23.)

136. **Levelness.** (See pars. 74 and 75.)

137. **Angle or Rear Furrow-Wheel.**—Instead of running against the furrow wall, the bottom of the rear furrow-wheel of most plows of this type runs a slight distance from the wall, and the wheel is angled to lead slightly away from the wall. Thus, the side thrust of the plow is partly cared for by the bearing surface of the landface of the landside, and partly offset by the rear furrow-wheel running at a slight angle to the furrow wall. Ordinarily, the rim of the rear furrow-wheel at the front side (at a point level with the bearing) is set about five-eighths inch farther from the furrow wall than a similar point on the rear side. This distance varies a little among different makes of plows, and the adjustments which secure the angle are so varied that they cannot be shown or described in detail here. Refer to the instruction book for your particular plow, or obtain information from the manufacturer on what the angle should be and how it is maintained.

138. **Landside Pressure .** (See par. 137.)

139. **Heel Clearance.**—Some plows of this type or designed to run with the heel of the landside of the rear bottom touching the bottom of the furrow lightly; others carry about three-eighths inch clearance between heel and bottom of furrow. Maintaining the proper heel clearance is of great importance. Refer to the instruction book for your particular plow, or obtain information from the manufacturer on what the heel clearance should be and how to maintain it.

140. **Connecting Rod.**—On some tractor plows the connecting or lifting rod, which runs to the rear furrow-wheel assembly from the lifting mechanism in front, is adjustable in length. For deep plowing, the connecting rod is shortened a little so that the rear of the plow will begin to rise as soon as the front end, insuring good clearance of the rear bottom above the surface while the plow is turning on the headland. In shallow plowing, lengthen an adjustable connecting rod. Otherwise the rod may prevent the rear beam from setting down onto and locking the rear furrow-wheel; then the plow may weave, proper heel clearance will not be maintained, and heavy draft and "bobbing" may result. If the connecting rod is adjustable, adjust its length so that it carries no weight while the plows are working, but "takes hold" quickly as soon as the plow begins to rise at the headland. Do not use an adjustable connecting rod to increase heel clearance. (See par. 139.)

141. Width of Cut.—The hitch of a tractor plow does not "float" horizontally as does the hitch on a horse plow. Hence the width of cut of the tractor sulky, and of the front bottom on a tractor gang, is controlled by the hitch instead of by the position of the front furrow-wheel in respect to the frame. On tractor plows, the front furrow-wheel stands vertically; it rolls in a line parallel to the furrow wall and at some distance from it, 2 inches being the customary distance when the front bottom of a plow of this type is cutting its normal width.

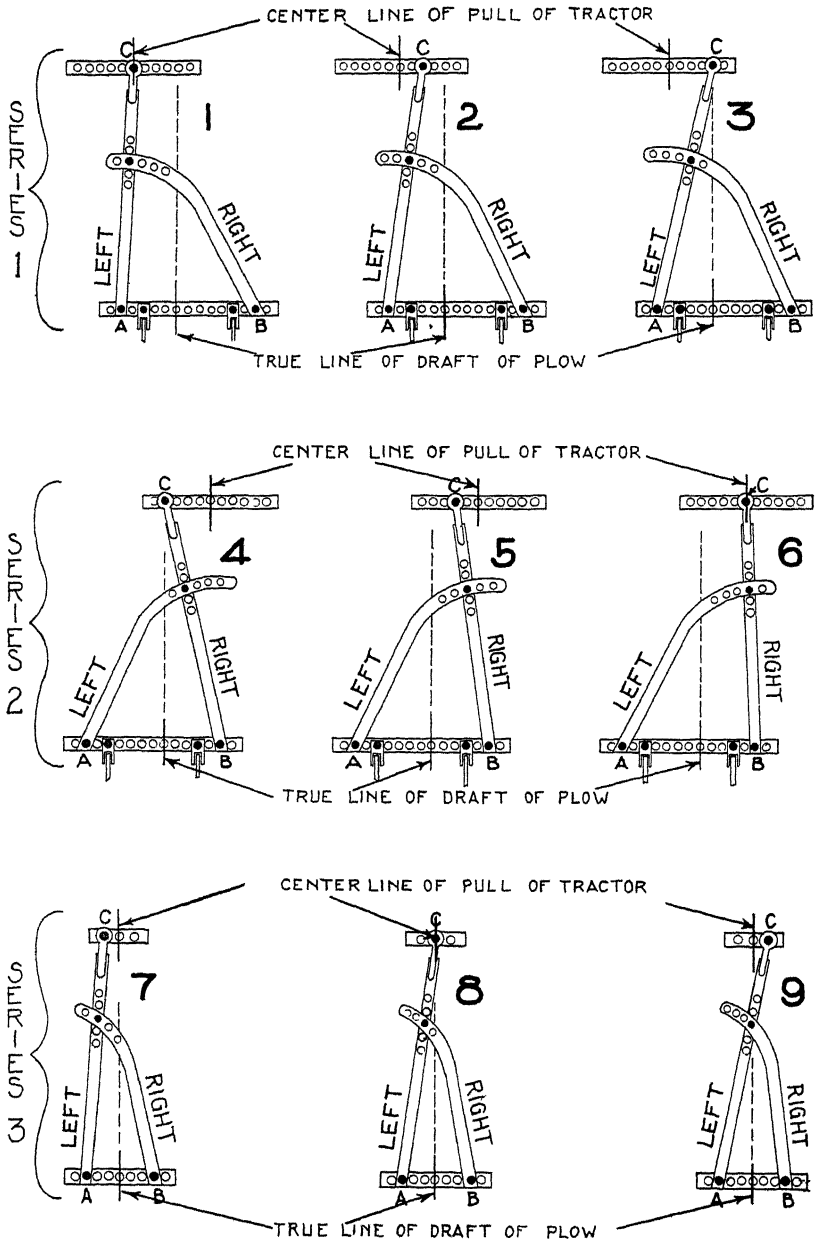
142. Refer to the illustrations on page 44 which show top views of common, "full-floating" hitch arrangements. Series 1 shows the arrangement of an outfit in which the true line of draft of the plow (See par. 77) is on the right of the center line of pull of the tractor (See par. 143). Series 2 shows the true line of draft on the left of the center line of pull. Series 3 shows the true line of draft approximately in line with the center line of pull. To change width of cut of the front plow, regardless of the sidedraft relationships, find the illustration on page 44 which pictures your hitch, then proceed as follows:

To decrease width of cut of front bottom: Move clevis C to the right on the draw-bar of the tractor; or lengthen the right hitch-bar in comparison to the left; or shorten the left hitch-bar in comparison to the right; or move points A and B equal distances to the left. Some plows do not carry the horizontal hitch plate; the draw-bars fasten by clevises directly to the vertical hitch plates on the front end of the beams. A horizontal hitch plate on the plow simply increases the range of adjustment. The effect of moving **either** A or B alone, instead of moving **both** an equal distance in the same direction, is too complicated for inclusion in this brief presentation. Moving clevis C usually effects a 2-inch change; changing the length of the bars in respect to one another must be done to make lesser changes.

To increase width of cut of the front bottom move clevis C to the left on the draw-bar of the tractor; or shorten the right hitch bar in comparison to the left; or lengthen the left hitch bar in comparison to the right; or move points A and B equal distances to the right.

Quick shift hitches are an advantage in rolling fields; with them, operators can shift the hitch without stopping the outfit.

143. Sidedraft.—The center line of pull in a four-wheeled tractor in which both rear wheels drive, may be considered for all practical purposes to be an imaginary line through the center hole of the draw-bar of the tractor and parallel to the open furrow. The follow-


CENTER LINE OF PULL OF TRACTOR
SERIES 1
1
2
3
LEFT
RIGHT
C
A
B
TRUE LINE OF DRAFT OF PLOW
SERIES 2
4
5
6
CENTER LINE OF PULL OF TRACTOR
TRUE LINE OF DRAFT OF PLOW
SERIES 3
7
8
9
CENTER LINE OF PULL OF TRACTOR
TRUE LINE OF DRAFT OF PLOW

ing table gives the approximate distances from the furrow wall of the open furrow to the true line of draft of various sizes of tractor sulkies and of gangs cutting their normal widths.

Number of bottom in plow	Size per bottom *Inches*	Distance from true line of draft of plow to furrow wall of open furrow *Inches*
1 (Sulky)	14	12
	16	14
	18	16
2 (Gang)	12	16
	14	19
	16	22
	18	25
3 (Gang)	12	22
	14	26
	16	30
	18	34
4 (Gang)	12	28
	14	33
	16	38

If there is to be no sidedraft in either the plow or the tractor, the center line of pull and the true line of draft must line up with one another, as in illustration 8 on page 44, and the clevis C must be attached in line with the center line of pull and true line of draft. This ideal relation is not often possible with large tractor plows when the right wheels of the tractor are run in the open furrow. If the true line of draft does not line up with the center line of pull, as in series 1 and 2 on page 44, sidedraft is sure to occur in the outfit. Then clevis C is usually attached to the draw-bar of the tractor about half way between the center line of pull and the true line of draft, as shown in illustrations 2 and 5 on page 44. Then the sidedraft effects in the outfit are somewhat evenly divided between the plow and tractor.

If too much sidedraft occurs in the plow (as evidenced by furrow wall breaking from excessive pressure of the rear landside, or by the plow running "twisted"), shift some of the sidedraft to the tractor by moving clevis C a little closer to the true line of draft, as in illustrations 3 and 4 on page 44. Then correct width of cut of front bottom by the adjustments given in paragraph 142.

If too much sidedraft exists in the tractor (as evidenced by the front or rear of the tractor being pulled sidewise to an objectionable degree), shift some of the sidedraft to the plow by moving clevis C a little nearer the center line of pull, as in illustrations 1 and 6 on page 44. Then correct width of cut of front bottom by the adjustments given in paragraph 142.

In hillside plowing, sidedraft effects are sometimes produced purposely, even when no sidedraft need exist. Illustrations 7 and 9 on page 44 show this. Some operators feel that the "artificial" sidedraft helps hold the units on the slope.

144. Hitch (Vertical).—Hitching too high on the plow is a quite common practice. When a plow in good adjustment is being used under good plowing conditions, attach the hitch bars low enough on the plow to let them point straight from the draw-bar of the tractor to the center of resistance of plow, as shown in Fig. 21. In other words, the line of hitch A B C should be straight—not broken upward or downward as would be the case if the hitch were too high or too low. If you are using a tractor in which the height of the draw-bar is adjustable, both the tractor draw-bar itself and the hitch bars should lie in a straight line from the center of resistance of the plow to that point under the tractor to which the draw-bar is attached. Keep the proper amount of down-suck in the

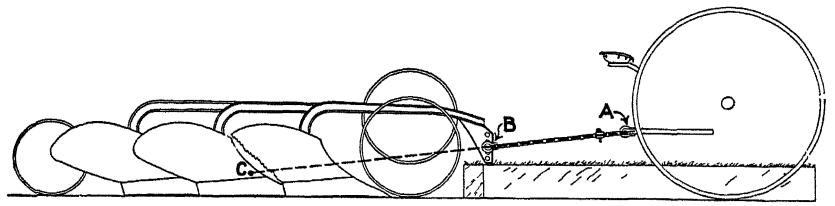


Fig 21.—Do not hitch too high on tractor gangs. Keep line of hitch as straight as possible.

shares, keep the shares sharp, maintain the proper heel clearance, so that the line of hitch can be as straight as possible.

When the line of hitch in a tractor plowing outfit is broken, it will tend to straighten just as a broken line of hitch on a walking plow. (See pars. 25 to 29.) If the hitch is too high on the plow, it will tend to "throw the plow on its nose," to increase the down thrusts on the front wheels, to lessen the weight on the rear wheel, to unlock the rear wheel and permit the plow to weave. If too low, the hitch will tend to raise the front of the plow, to interfere with penetration, to increase the weight on the rear wheel, to cause the land wheel to lose traction for lifting. Raising the hitch simply to offset dull shares is poor practice except for short periods. Obviously, in order to keep the line of hitch straight, the hitch bars should be higher on the plow in deep plowing; lower in shallow plowing. Plowmen can easily use the methods used by experts to judge the right height of hitch. Stand at one side of the outfit while it is standing as shown in Fig. 21, or while it is running. You can estimate the approximate location of the center of resistance of the

plow. Sight from that point to the draw-bar of the tractor. Do the hitch-bars lie in that imaginary line? Another method is the "wheel test," used on three-wheeled plows when the lifting wheel is not equipped with high lugs. While the plow is running, seize the front furrow-wheel at the top of its rim and hold it, if possible, causing the wheel to slide. Repeat on the rear furrow-wheel; then on the land-wheel. If the "feel" at the wheels indicates that the load downward is divided pretty evenly among them, the height of hitch is probably good. If the rear furrow wheel slides more easily than the other two, it is an indication that the hitch-bars are too high on the plow, and vice versa.

145. Under unusual or severe plowing conditions, raising or lowering the hitch is resorted to as a temporary expedient. In very hard ground, it may be necessary to raise the hitch in order to secure penetration. In very loose soils in which the plow tends to sink because the front wheels keep breaking through the surface, the hitch is often lowered to let the tractor carry more of the down thrust of the plow.

146. Hitch (Horizontal). (See pars. 141, 142, 143, and 144.)

147. Jointers. (See pars. 34 to 36.)

148. Coulters. (See pars. 37 to 44.)

149. Combination Jointer and Coulter. (See pars. 45 and 46.)

150. Special Covering Devices. (See pars. 47 to 52.)

RELATIVE VALUE OF COVERING DEVICES ON THREE-WHEELED TRACTOR PLOWS

151. See paragraph 115.

INDEX OF TROUBLES OF THREE-WHEELED TRACTOR PLOWS

COMMON CAUSES AND REMEDIES

See list on page 56.

2-3 WHEELED TRACTOR PLOWS WITH SEMI-FLOATING HITCH

A plow of this type may have one, two, or three plow bottoms. While the plow is working in the furrow, it is carried by all three wheels and the hitch is floating. That is, the plow and the tractor are independent of one another in their up and down movement in passing over the slight rises and through the slight depressions of an uneven surface. When the plow is lifted for the headland, its front end rises until the hitch reaches the upper limit of its floating action. The hitch then becomes rigid, and the rear of the plow is quickly raised quite high so that it can be turned or trans-

ported on the two front wheels. The hitch "floats" within certain limits; beyond those limits it is rigid. The plow turns on two wheels but plows on three. Hence the plow is called a "2-3 wheeler with semi-floating hitch." The rear furrow-wheel carries no lifting mechanism; no connecting or lifting rod runs to the rear wheel from the lifting mechanism in front.

152. The proper running of this type of plow depends largely upon securing and maintaining the proper down-suck, land-suck, wing fullness, sharpness, levelness, angle of rear furrow-wheel, landside pressure, heel clearance, width of cut, sidedraft relations, hitch, set of limits within which the hitch floats, and set and condition of jointer, coulter, and special covering devices.

153. **Down-suck and Land-suck.** (See pars. 18 and 19.)

154. **Wing Fullness.** (See par. 72.)

155. **Sharpness.** (See pars. 22 and 23.)

156. **Levelness.** (See pars. 74 and 75.)

157. **Angle of Rear Furrow-Wheel, Landside Pressure, and Heel Clearance.**—The rear furrow-wheel on most plows of this type is not adjustable. Hence, the angle of the rear furrow-wheel, and the clearance between the heel of the rear landside and the bottom of the furrow, cannot be varied. The pressure of the rear landside against the furrow wall is influenced by the sidedraft relation between the tractor and the plow, and can be changed somewhat by the hitch. (See par. 143.) If your plow carries an adjustable rear furrow-wheel, obtain information from the manufacturer as to how the rear furrow-wheel should lead, what heel clearance should exist, and what adjustments maintain these sets.

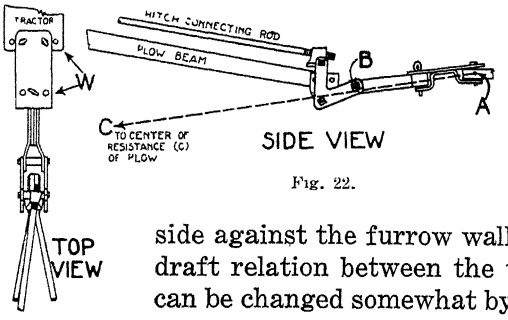


Fig. 22.

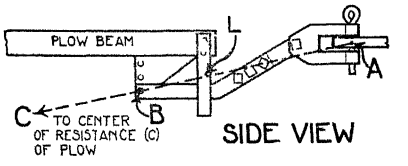


Fig. 23.

158. **Width of Cut and Sidedraft Relations.**—If your plow carries two hitch-bars similar in appearance and principle to any of those shown on page 44, read paragraphs 141 and 142. If your plow carries the hitch shown in Fig. 22, secure correct width of cut by moving the hitch to the right or left on the draw-bar of the tractor or at the series of holes at W. If your plow carries a hitch similar to the one in Fig. 23, secure correct width of cut at the draw-bar of the tractor.

159. Hitch (Vertical).—If your plow carries a hitch similar in appearance and principle to the one shown in Fig. 24, read paragraphs 144 and 145. If your plow carries the hitch shown in Fig. 22, the hitch is raised and lowered automatically as the depth of plowing is changed. This is accomplished by the bell-crank and by the hitch connecting rod which runs from the bell-crank to the land-wheel lever. By this arrangement, the line of hitch (See par. 144) is supposed to be kept straight because point B is raised or lowered automatically with the depth of plowing. However, if someone has carelessly lengthened the hitch connecting rod, point B may be too low and the line of hitch will be broken downward; if the connecting rod is too short, point B will be too high and the line of hitch will be broken upward. Such misadjustment may lead to serious difficulties as described in paragraph 144, see also paragraph 145. If your hitch is similar to that shown in Fig. 23, and you are plowing under good plowing conditions with the plow in good shape, hitch at such height on the hitch plate that point B will fall as near as possible in line as described in paragraph 144.

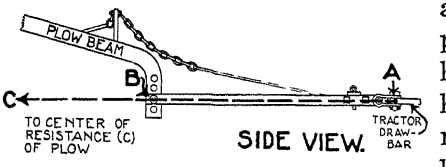


Fig. 24.

160. Hitch (Horizontal). (See par. 158.)

161. Limits Within Which Hitch Floats.—If your plow carries a hitch similar in appearance or principle to Fig. 24, see paragraphs 144 and 145 for height of hitch at point B, then adjust "limits" chain for length. The chain should be long enough to permit good, full-floating action in the hitch while the plow is working; yet short enough to raise the rear of the plow sufficiently when the plow is up. The chain must be longer for shallow plowing than for deep work. If your hitch is the one shown in Fig. 22, the floating action while the plow is at work is accomplished mostly by the play between the jaws of the hitch plate and the draw-bar of the tractor and between the draw-bar of the tractor and the draw-bar pin. If there is too much play, the rear of the plow may not be lifted high enough; such excessive play may occur because the hitch plate jaws have become spread, or through using a small draw-bar pin. If excessive "slop" at the draw-bar is the cause for the rear wheel not rising high enough, take out some of this play before you shorten the hitch connecting rod. (See par. 159.) If your hitch is similar to that shown in Fig. 23, keep point B low enough to be as nearly as possible in the straight line of hitch as described in paragraph 144. Then, if rear of plow does not rise high enough, take advantage of

the adjustment in the "limits" strap L.

162. **Jointer.** (See pars. 34 to 36.)

163. **Coulter.** (See pars. 37 to 44.)

164. **Combination Jointer and Coulter.** (See pars. 45 and 46.)

165. **Special Covering Devices.** (See pars. 47 to 52.)

RELATIVE VALUE OF COVERING DEVICES ON 2 AND 3 WHEELERS

166. See paragraph 115.

INDEX OF TROUBLES OF 2-3 WHEELERS

COMMON CAUSES AND REMEDIES

See list on page 56.

2-WHEELED TRACTOR PLOWS WITH SEMI-FLOATING HITCH

A plow of this type usually has one or two plow bottoms. It has only two wheels, a front furrow-wheel and a land-wheel. While plowing, the hitch floats. That is, the plow and the tractor are somewhat independent of one another in their up and down movement in passing over the slight rises and through the slight depressions of an uneven surface. When the plow is lifted for the headland, the front end of the plow rises until the hitch reaches the upper limit of its floating action; then the rear of the plow is quickly raised quite high. As there is no rear furrow-wheel, the heel of the rear landside furnishes the bearing surface against the bottom of the furrow.

167. The proper running of this type of plow depends largely upon securing and maintaining the proper down-suck, land-suck, wing fullness, sharpness, levelness, landside pressure, heel pressure, width of cut, sidedraft relations, hitch, set of the limits within which the hitch floats, and set and condition of jointer, coulter, and special covering devices.

168. **Down-Suck and Land-Suck.** (See pars. 18 and 19.)

169. **Wing Fullness.** (See par. 72.)

170. **Sharpness.** (See pars. 22 and 23.)

171. **Levelness.** (See pars. 74 and 75.)

172. **Landside Pressure.**—The pressure of the rear landside against the furrow wall is influenced by the sidedraft relation between tractor and plow, and can be varied somewhat by the hitch. (See par. 143.)

173. **Heel Pressure.**—Heel pressure is the pressure exerted by the heel of the rear landside against the bottom of the furrow. Un-

der good plowing conditions, with plow in good shape, the proper amount of heel pressure exists in this type of plow when the line of hitch in the vertical plane (See par. 144) is straight. If the line of hitch is broken upward, the heel may not "ride" the plow sole because the plow will be "nosed" down. If the line of hitch is broken downward there may be too much heel pressure (See pars. 179, 180, and 181).

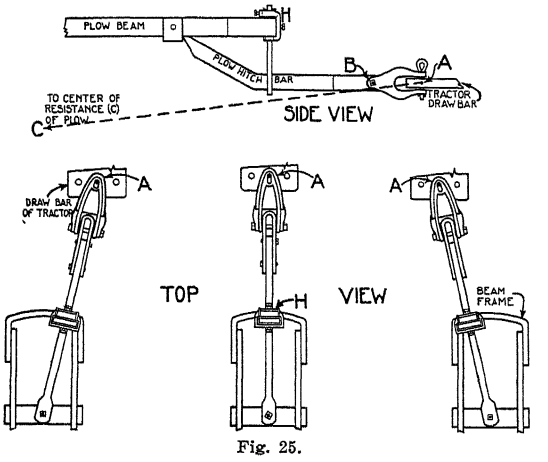


Fig. 25.

174. If your hitch is similar to that shown in Fig. 26, and you place the pin in hole P to render the hitch rigid, see paragraph 196.

175. Width of Cut. —If your hitch is similar in appearance and principle to those shown on page 44 and Fig. 24, refer to paragraphs 141 and 142. If your hitch is similar to that shown in Fig. 25, width of cut is controlled by swinging the plow hitch bar to the right or left in the frame of the plow, using adjustment H, or by shifting its front end to the right or left on the draw-bar of the tractor. Choice of the adjustments will depend largely upon the sidedraft relation between tractor and plow. (See par. 143.)

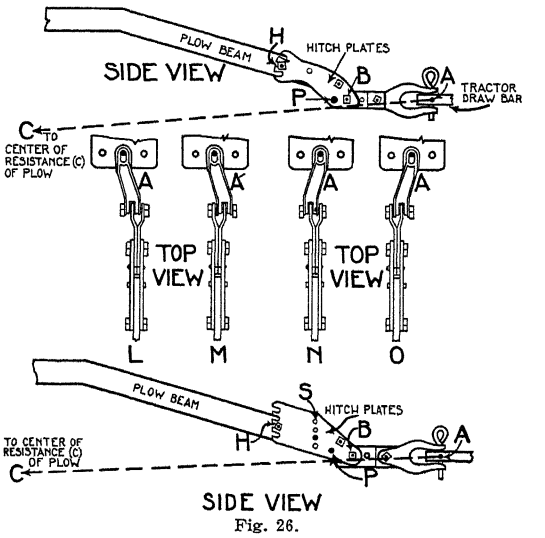


Fig. 26.

176. If your hitch is similar to that shown in Fig. 26, you can obtain approximately an inch change by setting the clevis A from position L to M, another inch by turning the clevis over and setting it as at N, then another inch by changing from position N to O. In addition to these means on the plow, you have

the holes in the draw-bar of the tractor by which to change width of cut still farther if necessary. Some plows of the type shown in Fig. 26 carry a stub beam which is reversible; one end is straight, the other end is offset as shown in Fig. 28. By reversing this stub beam, the front end of the beam can be brought farther to the left or right, depending upon which side of the stub beam is up. This adjustment affects sidedraft relations as well as width of cut.

177. **Sidedraft**—.If your hitch is similar in appearance and principle to those shown on page 44 and in Fig. 24, and if sidedraft becomes troublesome, refer to paragraphs 141 and 142. If your hitch is similar to Fig. 25, refer to paragraphs 141 and 142 to get principles in mind; then, if sidedraft becomes troublesome, proceed as follows: If too much sidedraft occurs in the plow, move clevis A in Fig. 25 nearer the true line of draft of the plow; then correct width of cut as described in paragraph 175. If too much sidedraft occurs in the tractor, move clevis A in Fig. 25 near the center line of pull of the tractor; then correct width of cut as described in paragraph 175.

178. If your plow carries a hitch similar to that shown in Fig. 26, and if sidedraft becomes troublesome, refer to paragraphs 141 and 142 to get principles in mind. Whether the draw-bar pin through clevis A in Fig. 26 is the center hole of the tractor draw-bar, or whether it is nearly in line with the true line of draft of the plow, depends upon which side of the clevis you place upward. If you must turn the clevis over to change the sidedraft relation between plow and tractor, correct width of cut as described in paragraph 176.

179. **Hitch (Vertical)**.—If your hitch is similar to those shown on page 44 and in Fig. 24, refer to paragraphs 144, 145, and 159.

180. If your plow carries a hitch similar to Fig. 25, raise or lower the plow hitch bar by adjustment H on the plow, until point B falls as nearly as possible in an imaginary straight line from the draw-bar of the tractor to the center of resistance (see Fig. 21) of the plow. Then, in good plowing conditions and with common outfits, the line of hitch will be as straight as possible. If point B is too high, the line of hitch will be broken upward; the tendency of the line of hitch to straighten will tend to throw the plow on its "nose," to rob the rear landside of the proper pressure downward. Then the plow may jump and gouge, and the draft may be increased. If point B is too low, the line of hitch will be broken downward; the tendency of the line of hitch to straighten may rob the plow of proper penetration, traction of the lifting wheel will be reduced, and heel pressure may be increased. Refer further to paragraph 173.

181. If your plow carries a hitch similar to Fig. 26, and the pin is removed from hole P to let the hitch float while plowing, raise or lower the hitch plate by adjusting H until point B is in line as described in paragraph 180. If you place pin P so that the hitch is robbed of floating action, see paragraph 196. The hitch plates shown in Fig. 26 can be reversed to accommodate the plow at various depths of plowing to various heights of tractor draw-bars.

182. **Hitch (Horizontal).** (See pars. 175 to 178.)

183. **Set of Limits Within Which Hitch Floats.**—If your plow carries a hitch similar to those on page 44 and Fig. 24, refer to paragraph 161. If you raise or lower the plow hitch bar shown in Fig. 25, or if you change the hitch plate in Fig. 26, simply to cause the rear of the plow to rise higher, you may seriously upset heel pressure, line of hitch, and proper floating action. (See 173, 174, 180, and 181.)

184. **Jointer.** (See pars. 34 to 36.)

185. **Coulter.** (See pars. 37 to 44.)

186. **Combination Jointer and Coulter.** (See pars. 45 and 46.)

187. **Special Covering Devices.** (See pars. 47 to 52.)

RELATIVE VALUE OF COVERING DEVICES ON 2-WHEELED TRACTOR PLOWS

188. See paragraph 115.

INDEX OF TROUBLES OF 2-WHEELED TRACTOR PLOWS

COMMON CAUSES AND REMEDIES

See list on page 56.

2-WHEELED TRACTOR PLOWS WITH RIGID HITCH

A plow of this type usually is a gang of two plow bottoms. It has two wheels—no rear furrow-wheel. The hitch, shown in Fig. 27, is rigid at all times. That is, it has no free movement vertically except through what play exists between the draw-bar of the tractor and the clevis of the plow, or between the clevis of the plow and the hitch plates on the beam. The rigid hitch makes it possible to keep the heel of the rear landside above the bottom of the furrow, the clearance under the heel, for all depths of plowing, being controlled by adjustment H in the hitch plates shown in Fig. 27.

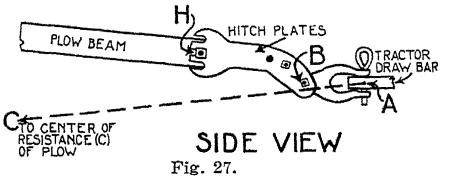


Fig. 27.

189. The proper running of this type depends largely on securing and maintaining the proper down-suck, land-suck, wing fullness, sharpness, levelness, landside pressure, heel clearance, width of cut, sidedraft relations, hitch and set and on the condition of jointer, coulter, and special covering devices.

190. Down-Suck and Land-Suck. (See pars. 18 and 19.)

191. Wing Fullness. (See par. 72.)

192. Sharpness. (See pars. 22 and 23.)

193. Levelness. (See pars. 74 and 75.)

194. Landside Pressure.—The pressure of the rear landside against the furrow wall is influenced by the sidedraft relation between tractor and plow, and can be varied somewhat by the hitch. (See par. 178.)

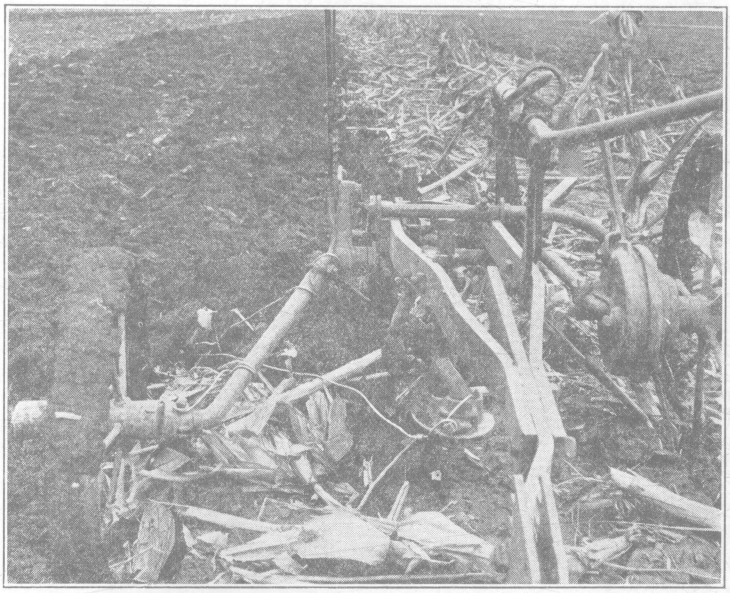
195. Heel Clearance.—When a typical, rigid hitch (Fig. 27) is used, the hitch plates should be set with adjustment H to allow from $\frac{3}{8}$ inch to $\frac{1}{2}$ inch clearance between the heel of the rear landside and the bottom of the furrow. This clearance should exist when the plow is running. The hitch plates can be reversed to accommodate this plow to deep work. Adjustment H must be used to maintain proper heel clearance when the depth of plowing is changed. Heel clearance should be watched closely as it varies with seasons and soil conditions.

196. If you use a hitch similar to Fig. 26 with pin in hole P to render the hitch rigid, adjust the hitch plates at H so that the heel of the rear landside "rides" the bottom of the furrow lightly. In the hitch illustrated at the bottom of Fig. 26, the range of the adjustment at H is increased by the series of holes at S. In the hitch illustrated at the top of Fig. 26, you will probably find a series of holes at the back end of the clevis itself; pin P passes through one

of these holes. These means of increasing the range of adjustment H permits the operator to maintain a good line of hitch in the vertical plane (See par. 144) whether the plow is working deep with a rather high draw-bar on the tractor, or shallow with a low draw-bar on tractor. Be sure to read paragraph 199.

197. Width of Cut. (See par. 176.)

198. Sidedraft Relation. (See par. 178.)



Courtesy U. S. Dept. Agriculture

Fig. 28.—A good method of attaching covering wires to a wide base tractor sulky.

199. Hitch (Vertical.—If your hitch is similar to that shown in Fig. 27, see paragraph 195. If your hitch is similar to Fig. 26 and you place pin in hole P to render the hitch rigid, keep point B as nearly as possible in line, as described in paragraph 181, and yet maintain the proper heel pressure as described in paragraph 196.

200. Hitch (Horizontal). (See pars. 176 and 178.)

201. Jointer. (See pars. 34 to 36.)

202. Coulter. (See pars. 37 to 44.)

203. Combination Jointer and Coulter. (See pars. 45 and 46.)

204. Special Covering Devices. (See pars. 47 to 52.)

RELATIVE VALUE OF COVERING DEVICES ON 2-WHEELED TRACTOR PLOWS

205. See paragraph 115.

INDEX OF TRACTOR PLOW TROUBLES

COMMON CAUSES AND REMEDIES

Where references in this index refer to a subject, thus, "See Levelness," turn back to the discussion of that subject under the title of the kind of plow you have, whether it is a

3-Wheeler with full floating hitch..... Page 41
2-3 Wheeler with semi-floating hitch..... " 47
2-Wheeler with semi-floating hitch..... " 50
2-Wheeler with rigid hitch ..... " 54

206. Failure to penetrate.

1. Dull share. (See pars. 22 and 23.)
2. Down-suck or land-suck wrong. (See pars. 18 and 19.)
3. Hitch too low. (See Hitch.)
4. Improper heel clearance. (See Heel Clearance.)
5. Coulter dull or set too far forward in hard ground. (See pars. 42 and 44.)
6. Nonscouring. (See par. 127.)
7. Lifting springs too tight in hard ground plowing.
8. See paragraphs 208 and 209.

207. Difficulty in holding depth in very soft ground.

1. Too much down-suck. (See pars. 18 and 19.)
2. Improper amount of heel clearance. (See Heel Clearance.)
3. Hitch too high. (See par. 145.)
4. See paragraphs 208 and 210.

208. Furrows deeper or shallower than those of the preceding trip, yet field conditions for plowing are good.

1. Plow not level. (See par. 74.)
2. Front furrow-wheel not on same plane as cutting edge of front share. (See par. 74.)
3. See paragraphs 206 and 207.

209. Furrows shallower than those of preceding trip, where ground is hard.

1. Possibility of running plow low on land wheel. (See pars. 74 and 75.)
2. See paragraph 206.

210. Furrows deeper than those of preceding trip, when ground is very soft.

1. Possibility of running plow high on land wheel, or running front furrow-wheel lower than front share when frame is level. (See pars. 74 and 75.)
2. See paragraph 207.

211. Failure to hold width.

1. Hitch wrong. (See Width and Sidedraft.)
2. Land-suck wrong. (See pars. 18 and 19.)
3. Standing coulters. (See par. 37.)
4. See paragraph 212.

212. Plow tends to run "twisted"at too great angle to open furrow.

1. Excessive sidedraft in plow. (See Width of Cut, Sidedraft and Hitch.)
3. See paragraph 226.

213. **Failure to properly cover trash.**
1. Absence of jointer, coulter and special covering devices; or poor set or adjustment of same. (See pars. 34 to 52.)
2. Relation of depth of plowing to width of plow. (See pars. 10 and 11.)
3. Badly worn wing of moldboard.
4. Plow not held in proper position relative to furrow slice . (See pars. 211 and 212.)
5. Nonscouring. (See par. 127.)
6. Speed. (See par. 14.)
7. See paragraph 64, point 8.
8. Loose bottom.

214. **Failure to properly granulate and handle furrow slice.**
1. See paragraphs 211, 212, and 213.
2. See paragraph 64, point 8.

215. **Furrow crowns not of equal height.** Very common with gangs. Highly objectionable from standpoint of uniformity in plowing, and in granulation by subsequent tillage operations.
1. Front bottom cutting wider or narrower than other bottom or bottoms. (See width of Cut.)
2. Coulters not set alike.
3. Plow not level. (See par. 74.)
4. Land wheel on corn row or one bottom is plowing corn row.
5. One plow bottom plowing up track left by tractor drive wheel.
6. Nonscouring. (See par. 127.)
7. Bent beam. (See par. 226.)
8. See paragraph 216.
9. Loose bottom.
10. Moldboard extensions not set uniformly.
11. Rear bottom too high or too low in comparison to other bottoms, when the fourth or third bottom has been attached to a 3-4 or a 2-3 bottom plow. Test by sighting underneath and across the cutting edges of shares. (See further under Bent Beams, par. 226.)
12. "Broken-back" on 3-bottom or 4-bottom plow.

    Many large plows carry a special reinforcement to support the center of the plow directly over the bottoms. If this reinforcement is removed, and even sometimes when it is in place, the plow will sag in the center. That is, the middle bottom or bottoms get lower than the front and rear. Inspect by sighting underneath and across the cutting edges of shares. If sagging has occurred, and the sag is not due to bent beams, the center of the plow often can be drawn back into place by placing a heavy bar across all beams and parallel to the line of the bottoms; loosening yokes and rear braces slightly; then by means of heavy U-bolts drawing the center beams up; tightening all yokes and braces. This process should not be resorted to in an attempt to overcome bent beams. (See Bent Beams, par. 226.)

216. **Furrow crowns not of equal curvature; not similar in shape.**
1. See all points under paragraph 215.

217. **Furrow wall breaking.**
1. Coulter or jointer set wrong. (See pars. 37-46.)
2. Excessive sidedraft in plow. (See Width, Sidedraft, and Hitch.)
3. Angle of rear furrow-wheel. (See Landside Pressure.)

4. Badly worn shin. (See point 2 under par. 63.)
5. Land-suck wrong. (See pars. 18 and 19.)
6. Dull share. (See pars. 22 and 23.)
7. Rear bottom plowing up track of tractor drive wheel.

218. **Excesive landside pressure.**
1. Too much sidedraft in plow. (See Width of Cut, Sidedraft and Hitch.)
2. See Landside Pressure.

219. **Excessive draft.**
1. Dull shares. (See pars. 22 and 23.)
2. Too much down-suck or land-suck in share. (See pars. 18 and 19.)
3. Improper heel clearance. (See Heel Clearance.)
4. Dull coulters or coulters not used. Bandly worn shin when coulters are not used.
5. Hitch too high. (See Hitch.)
6. Excesive sidedraft. (See Width of Cut, Sidedraft, and Hitch.)
7. Excessive landside pressure. (See Landside Pressure.)
8. Nonscouring. (See par. 127.)
9. Bent beam. (See par. 226.)

220. **Failure to scour (nonscouring).** (See par. 127.)

221. **Shoving.** (See par. 128.)

222. **Bobbing, jumping, gouging.** Instead of holding steadily to its depth, the plow gouges along; sucks to its depth, then jump up; "bobs."
1. Dull share. (See pars. 22 and 23.)
2. Too much down-suck in share. (See pars. 18 and 19.)
3. Hitch too high. (See Hitch.)
4. Dull coulter. (See par. 44.)
5. Coulter set too low, or not in proper position on beam, for hard ground. See par. 42.)
6. Heel clearance or heel pressure not correct. (See Heel Clearance.)
7. Bent beam. See par. 226.)

223. **Plow come to lesser depth as headland is approached.** (See par. 130.)

224. **Dribble.**
1. Coulter not set properly. (See pars. 35 to 44.)
2. Rear bottom loose.
3. Rear beam bent. (See par. 226.)
4. Nonscouring. (See par. 127.)
5. Rear bottom plowing up track of tractor drive wheel.

225. **Weaving.** Plow weaves from side to side.
1. Rear furrow-wheel not locked. (See Heel Clearance, Connecting Rod, and Hitch.)
3. Collars or castings loose, permitting the beams to shift from side to side on bails.
4. Dull share. (See pars. 22 and 23.)
5. Too much down-suck in share. (See pars. 18 and 19.)
6. Dull coulter; or coulter set too deep or in wrong position on beam. (See pars. 42 to 44.)
7. Heel clearance wrong. (See Heel Clearance.)

226. **Bent Beams.** Beams are sometimes bent vertically, horizontally, or both vertically and horizontally. On tractor plows the most serious bending is that which occurs in the curve of the beam above the plow bottom. When a beam is bent vertically the plow bottom points up, or points down too much. When a beam is bent horizontally, the bottom points either toward the plowed ground, or too much toward the unplowed ground. Bent frogs sometimes give the same effects as bent beams.

Bent beams or bent frogs lead to serious troubles which are misleading and baffling. On the other hand there is too much tendency on the part of operators to believe that a beam is bent when in fact the trouble is due simply to poor sets or adjustments at other points on the plow. Perhaps a steel share has become badly bent due to the plow's dropping hard at the headlands. Do not assume that you have a bent beam until you have checked up on all the points in the section about your plow mentioned as affecting good operation. Often bent shares can be detected by methods described in paragraphs 18 and 19. Bent beams and bent frogs usually are hard to detect, but the following suggestions may prove helpful. In reading these suggestions, remember that a beam may be bent both vertically and horizontally and you have to test the planes separately.

1. *Beam bent vertically on single bottom tractor plow.* If the bend is slight, no serious ill effects need result if the trouble can be overcome by the hitch when the proper heel clearance is maintained. See Heel Clearance, and Hitch.) If the bend is severe enough to throw the hitch beyond its range of adjustment, some remedy should be sought.

See that the frog is tight on beam. Put on a new share of right kind and size; also a new heel piece if the landside carries a renewable heel. Let the bottom down on a smooth floor; place a 6-inch block under land-wheel. Level the frame as much as possible, still leaving the wing and point of share and the heel of the landside on the floor. Take measurement vertically from the floor (at the point of the share) to the underside of the beam as at A in Fig. 29; also from the floor to the underside of the beam proper at its extreme front end as at B. Send sketch like Fig. 29 to the manufacturer, marking on the sketch the distances you find at A and B. Be accurate, so the manufacturer can know to just which points you measured. Be sure to send the proper information as to size, type, and number of your plow. Most manufacturers will gladly assist, and will let you know what to do if the beam is bent. If this system of measuring is used on a single bottom plow carrying an adjustable rear furrow-wheel, be sure to have the proper heel clearance when the measurements are taken.

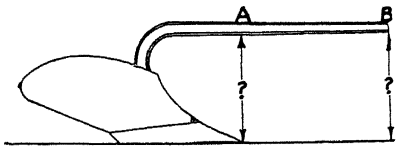


Fig 29.

2. *To inspect for beam bent vertically on 2-bottom gang.* Be sure that each frog is tight on beam; also that all yokes and braces between beams are tight. The shares should be in the same conditions as to wear, or should be new ones of the right kind and size. While the bottoms are raised on wheels, stoop down, a few feet ahead of the plow, in position to sight underneath the shares. Are the cutting edges of the shares parallel

to one another in the horizontal plans? If you suspect that one beam is bent vertically, take measurement A, Fig. 29, on that bottom. Send this to manufacturer as suggested in point 1 above.

3. *To inspect for beam bent vertically on 3-bottom or 4-bottom gang.* Be sure each frog is tight on its beam. Be sure also that the rear bottom is not high or low as described in point 11, paragraph 215, and that the plow has not a "broken back" as described in point 12, paragraph 215. See that all yokes and braces between beams are tight. Shares should be in same condition as to wear, or new ones of the right kind and size. Then inspect for bent beam by the sighting method described in point 2 above. Are the cutting edges of the shares parallel to each other in the horizontal plane? Are the wings approximately in line? Are the points of shares even? You can check further by taking measurement A in Fig. 29. If you are sure a beam is bent, obtain advice from manufacturer.

4. *To inspect for beam bent horizontally on single-bottom plow.* On most tractor plows the beam runs forward parallel to the landside of the plow bottom. The point of the share points a little to the left as shown in Fig. 3. Sight down the landside of the beam. Does it line-up approximately parallel with the plane of the land face of the landside? Before doing this be sure the frog is tight on the beam. Do not be misled by the land-suck of the share. (See pars. 18 and 19.) A beam bent horizontally to a slight degree is not so serious on single-bottom plows as on gangs. Often it can be helped by shimming up between the frog and the beam foot. If the beam must be bent back into shape, obtain advice from manufacturer.

5. *To inspect for beam bent horizontally on 2-bottom gang.* Be sure that frogs are tight on beams. If the shares are worn to the same degree, measure between the joints of the shares at P in Fig. 30; then between *similar* points at the wings of the molds as at Q in Fig. 30. If there is more than an inch difference in these measurements, you may suspect that one bottom is twisted or its beam bent. Sight, as described in point 4, above, to detect if possible which bottom is "off." Shimming between the frog and beam may help materially. If one beam must be bent back into shape obtain advice from the manufacturer.

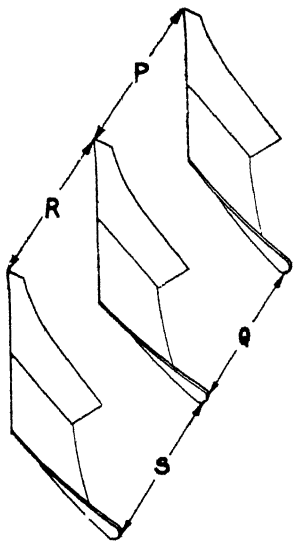


Fig. 30.

6. *To inspect for beam bent horizontally in 3-bottom or 4-bottom plow.* Be sure that frogs are tight on beams. If the shares are worn to the same degree, take measurements P and R, Fig. 30, between the points of the shares. Then take Q and S between *similar* points at the wings of the molds. Allowing about an inch for natural variation, the relation between P, Q, R and S will indicate which one of the bottoms is "off." Use the same method on a 4-bottom plow. Shimming between frog and beam may help materially. If any beam must be bent back into shape, obtain advice from manufacturer.

227. Lifting wheel slips.

1. Clutch trouble.
2. Improper heel clearance. (See Heel learance.)
3. Lifting springs too loose.
4. Down-suck wrong. (See pars. 18 and 19.)
5. Loose condition of surface.

228. Plow enters slowly at headland.

1. Dull shares. (See pars. 22 and 23.)
2. Lifting springs too tight.
3. Clutch trouble.

229. Excessive break-pin breakage under good plowing conditions.

1. Wrong kind of wood. Use kind recommended by manufacturer.
2. Pin does not fill hole. See that pin fully fills the break-pin holes.
3. Pieces through which pin passes do not fit closely. The pieces through which the pin passes sometimes spread apart; the break-pin cannot stand the resulting leverage. Keep the sliding faces parallel and close to one another.
4. Operator fails to "ease" the tractor into its load.

Note: Special warning must be given regarding the attachment and detachment of the rear bottom and beam of 2-3 and 3-4 bottom gangs. In attaching or detaching the rear bottom, usually five changes have to be made: (a) the rear furrow-wheel; (b) the connecting rod; (c) the landside of rear bottom; (d) lifting springs, and (e) the hitch. In attaching a rear bottom be sure to have it line up properly with the others, as suggested in point 11, paragraph 215. Also be sure to put the long landside on the rear bottom.

OTHER AVAILABLE MATERIAL

Laying Out Fields for Tractor Plowing. Farmers Bulletin, 1045; U. S. Department of Agriculture.

Better Plowing. Circular 450; College of Agriculture, University of Illinois.

Hitching Horses to Get the Most Work Done. Circular 283; College of Agriculture, University of Illinois.

Bulletin and leaflets on tandem hitches. By the Horse Association of America.

Instruction books, and instruction sheets on plow adjustments; instructions on how to care for and sharpen plow shares. By the various manufacturers of plows.

The Oliver Plow Book. By the Oliver Chilled Plow Works.

The Care and Operation of Plows and Cultivators. By Deere and Company.

Tractor Plowing at Its Best. By the International Harvester Company.

Plow Manual. By J. I. Case Threshing Machine Company.